Dear Colleagues,

Welcome to the ASNR 46th Annual Meeting and NER Foundation Symposium 2008. Dr. Robert D. Zimmerman from Weill Cornell Medical Center, President-Elect of the ASNR and this year’s Program Committee Chair, has worked with members of his committee to present topical and significant educational and scientific material for this year’s programming.

The NER Foundation Symposium 2008: Emergency Neuroradiology will be educationally beneficial for all attendees, both specialists and generalists. Discussions will focus on “state of the art” imaging and treatment of acute events, the needs of referring physicians, and current state and future trends in coverage of emergent neuroradiology services.

The Annual Meeting features proposed Self Assessment Module (SAM) sessions in each of the subspecialty areas of neuroradiology, a general content SAM session mock board examination sessions in brain, spine, head and neck, and advanced imaging, Electronic Learning Center (ELC), and Business Center programming. Focus Sessions developed in cooperation with the American Society of Functional Neuroradiology (ASFNR), American Society of Head and Neck Radiology (ASHNR), American Society of Pediatric Neuroradiology (ASPNR), American Society of Spine Radiology (ASSR), and the Society of NeuroInterventional Surgery (SNIS) cover a wide range of topics of interest for both the sub-specialist and general neuroradiologists. Once again, attendees may take the American Board of Radiology (ABR) neuroradiology MOC recertification examination at the end of the annual meeting.

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

- American Society of Functional Neuroradiology (ASFNR) .....................................................Jay J. Pillai, MD
- American Society of Head and Neck Radiology (ASHNR) .....................................................Edward E. Kassel, MD
- American Society of Pediatric Neuroradiology (ASPNR) .....................................................Jill V. Hunter, MD
- American Society of Spine Radiology (ASSR) ...........................................................................Erin Simon Schwartz, MD
- Society of NeuroInterventional Surgery (SNIS) .........................................................................Robert W. Tarr, MD

The annual meeting provides a unique opportunity to gain a better understanding of how the ASNR functions to assist the practice of neuroradiology during a time of rapid change. We look forward to your participation at the “Taste of the Big Easy” Reception with Technical Exhibitors on Tuesday evening. The meeting also provides excellent opportunities to renew old friendships and make new ones as well as exchange ideas and share conversation with world-renowned researchers and clinicians.

I congratulate Bob Zimmerman and his committee for constructing a fine program. I welcome all attendees to one of the best products the ASNR produces---the annual meeting. Allow me to greet you personally on the floor of the convention.

Sincerely,

David M. Yousem, MD, MBA
ASNR President
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About New Orleans

The ASNR 46th Annual Meeting and NER Foundation Symposium 2008 host venue is the Ernest N. Morial Convention Center. The center is considered one of the premier U.S. convention centers. Located along the mighty Mississippi River, within walking distance of the French Quarter, Jackson Square, the Aquarium of the Americas and the Hilton New Orleans Riverside, our headquarters hotel.

What to do in New Orleans? The answer is simple yet resounding. Do as the New Orleanians do: indulge, savor and celebrate.

It is an indisputable fact that no place loves its food quite as sincerely – or as indulgently – as New Orleans. A po-boy from a corner stand, to Emeril’s or Mr. B’s.

Don’t be fooled, New Orleans has much more to offer than fantastic food! Check out the French Quarter for some fine shops and historical sites. If you are a nature lover the Audubon Aquarium of the Americas is a short distance away. Whatever you are seeking...New Orleans has it for you!!

Walking Map of New Orleans

ASNR would like to thank Northstar Travel Media, LLC for the use of their New Orleans, Louisiana map.
General Information

Meeting Registration
Registration will take place in Hall A Foyer at the Ernest N. Morial Convention Center. The registration desk will be open during the following hours:

Saturday, May 31 ..................................7:00 am - 6:00 pm
Sunday, June 1 ..................................6:30 am - 6:00 pm
Monday, June 2 ..................................6:30 am - 6:00 pm
Tuesday, June 3 ..................................6:30 am - 6:00 pm
Wednesday, June 4 ..........................6:30 am - 6:00 pm
Thursday, June 5 ..................................6:30 am - 6:00 pm

Speaker Ready Room Location & Hours
Ernest N. Morial Convention Center - Room 210
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, ASPNR, ASSR,
or SNIS Member ......................................................Blue
Non-Member ............................................................Green
Fellow/Trainee ..............................................................Tan
Other Professional ....................................................Yellow
Guest .................................................................Gold
Exhibitor ..............................................................Peach
Staff .................................................................Purple

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

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

CME & E-Access Message Pavilion
The CME & E-Access Message Pavilion locations in the convention center include Room 203 and Hall A. Computer terminals will be available to registered attendees that can be used to evaluate attended sessions, print CME certificates, access/send external email and to leave internal messages for other attendees.

CME & E-Access Message Pavilion Locations

Location 1: Room 203
Ernest N. Morial Convention Center
Saturday, May 31 ..........................7:00 am - 9:00 pm
Sunday, June 1 through Thursday, June 5 ..........................6:30 am - 9:00 pm

Location 2: Hall A
Ernest N. Morial Convention Center
Tuesday, June 2 and Wednesday, June 3 ..........................10:15 am - 4:00 pm
Thursday, June 4 ..........................10:00 am - 4:00 pm

Ernest N. Morial Convention Center
Ernest N. Morial Convention Center
900 Convention Center Boulevard
New Orleans, Louisiana 70130
Phone: 504-582-3000

Coat Check
Near Mosaic Fountain (Street Level)

Hours of Operation:
Saturday, May 31 ..........................6:30 am - 6:00 pm
Sunday, June 1 ..........................6:00 am - 7:00 pm
Monday, June 2 through Wednesday, June 4 ..........................6:00 am - 8:00 pm

Emergency Service Procedure
To Report an Emergency in the Ernest N. Morial Convention Center:
• Locate a red emergency telephone in area telephone bank.
• Dial 1911 or 3040 from any non-coin operated telephone.
• Or use the telephone in the green box outside the medical rooms in lobby B, E, H, or C.

Nearest Hospital/Urgent Care
Woessner Clinic
750 Camp Street, New Orleans
Phone: 504-525-5262
Hours: Monday - Friday 9:00 am - 4:00 pm

24 Hour Hospital
Tulane Medical Hospital
1415 Tulane Avenue, New Orleans
Phone: 504-988-5800

Pharmacy
Walgreens - Store #5040
1801 Saint Charles Avenue, New Orleans
Open 24 hours | 7 Days a week
Phone: 504-561-8458
General Information (continued)

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

Continental Breakfast
Sunday, June 1 through Thursday, June 5 ..................La Louisiane Ballroom Foyer
Morning Breaks
Sunday, June 1 and Monday, June 2 ......................La Louisiane Ballroom Foyer
Tuesday, June 3 through Thursday, June 5 ....................................................Hall A
Box Lunches
Sunday, June 1 and Monday, June 2 ....................La Louisiane Ballroom Foyer
Tuesday, June 3 through Thursday, June 5 ....................................................Hall A
Afternoon Breaks
Saturday, May 31 through Monday, June 2 ....................La Louisiane Ballroom Foyer
Tuesday, June 3 through Thursday, June 5 ....................................................Hall A

AJNR - Hall A Foyer
All attendees are invited to stop by the booth any time to test drive the new Website and take advantage of the meeting discount on subscriptions.

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

AJNR Booth Schedule
Saturday, May 31 .................................12:00 pm - 4:30 pm
Sunday, June 1 through Thursday, June 5 .................................8:30 am - 4:30 pm

Meeting Location: Ernest N. Morial Conference Center
NOTE: All scientific sessions and exhibits are located at the Ernest N. Morial Convention Center.

Registration
Hall A Foyer

CME Pavilion Terminals
Room 203 and Hall A

E-Access/Messaging Center
Room 203 and Hall A

How-To Breakfast and Lunch Sessions
La Louisiane Ballroom

Focus/Scientific Paper Sessions
La Louisiane Ballroom, Room 206/207, Room 208/209 and Room 211/212

Electronic Learning Center (ELC)
Workshops & Lectures
Room 204/205

Business Center Programming
Room 201/202

EXHIBITS
Scientific Exhibits, Electronic Scientific Exhibits (eSE), Scientific Posters
Hall B1

Technical Exhibits
Hall A

MISCELLANEOUS
American Board of Radiology (ABR) Literature Desk
ABR Exam Room
Room 204/205

American Journal of Neuroradiology (AJNR) Desk
Hall A Foyer

Coat Check
Near Mosaic Fountain (Hall A Foyer)

Headquarters Office
Room 214

Meetings & Announcements Board and Job Postings Board
Hall A Foyer

Restaurant Reservations
Hall A Foyer

Speaker Ready Room
Room 210

VIP Lounge
Room 215
Guest Hospitality
Hilton New Orleans Riverside Hotel
Port/Starboard Room
The Guest Hospitality area, available to those who have registered for the hospitality program, 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. Continental breakfast and beverages will be available from Sunday, June 1 through Thursday, June 5. Guest Hospitality is a great place to start the day, and an ideal location to see old friends and acquaintances. Stop by Sunday through Tuesday at 9am for presentation about local historical sites, shops, and much more!
Information is available in the Guest Hospitality area on local attractions.

Guest Hospitality Hours
Sunday, June 1 through Thursday, June 5 ............................8:00 am – 10:00 am

Social Program
“A Taste of the Big Easy”
Reception with Technical Exhibitors
Ernest N. Morial Convention Center
Tuesday, June 3, 2008
Reception: 6:30 pm - 8:00 pm (Hall A)
Entertainment: 8:00 pm - 9:30 pm (La Louisiane Ballroom)
The ASNR reception with Technical Exhibitors offers the perfect opportunity to see this year’s Technical Exhibits...the ASNR’s annual showcase for the newest products and services in 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.

Join us to pay tribute to the traditions of classic southern Louisiana cuisine in a welcoming and friendly atmosphere. For your entertainment, we present Traditional, Creole Jazz and Cajun music, the cultural root of New Orleans.
This casual social setting also 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.

Ticket required for admission
A ticket to the Reception is included in the fee for registration categories that include Tuesday, June 3 and in the Guest Hospitality fee.
ASNRFUTUREANNUALMEETINGS

VANCOUVER2009

47thAnnualMeeting
May16-21,2009|VancouverConvention&ExhibitionCentre
Vancouver,B.C.,Canada

2010
48thAnnualMeeting
May15-20
HynesConventionCenter
Boston,Massachusetts

2011
49thAnnualMeeting
June4-9
WashingtonStateConvention
andTradeCenter
Seattle,Washington

2012
50thAnnualMeeting
April21-26
NewYorkHilton
NewYork,NewYork

2013
51stAnnualMeeting
May18-23
SanDiegoConventionCenter
SanDiego,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, DC

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

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

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

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

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

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

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

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

Seventeenth Annual Meeting
May 20-24, 1979
Hotel San Diego
San Diego

EIGHTEENTH ANNUAL MEETING
March 16-21, 1980
Century Plaza
Los Angeles

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

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

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

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

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

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

Twenty-Fifth Annual Meeting
(Silver Anniversary)
May 10-15, 1987
New York Hilton
New York

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

Twenty-Seventh Annual Meeting
March 19-24, 1989
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
Washington Hilton and Towers
Washington, DC

Thirty-First Annual Meeting
May 5-9, 1991
Adam’s Mark
St. Louis

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

Thirty-Third Annual Meeting
May 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 17-21, 1998
(Pennsylvania Convention Center)
Philadelphia

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

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

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

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

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

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

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

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

Forty-Fifth Annual Meeting
June 9-14, 2007
Hyatt Regency Chicago
Chicago
ASNR Past Presidents and Founders

1962-64 Juan M. Taveras, MD*
1964-65 Mannie M. Schechter, MD*
1965-66 Donald L. McRae, MD*
1966-67 Ernest H. Wood, MD*
1967-68 Harold O. Peterson, MD*
1968-69 Colin B. Holman, MD
1969-70 Giovanni Di Chiro, MD*
1970-71 D. Gordon Potts, MD
1971-72 Norman E. Chase, MD
1972-73 Fred J. Hodges, III, MD*
1973-74 T. Hans Newton, MD
1974-75 Hllier L. Baker, Jr., MD
1975-76 Irvin I. Kriceheff, MD
1976-77 Norman E. Leeds, MD
1977-78 Sadek K. Hilal, MD*
1978-79 Stephen A. Kieffer, MD
1979-80 David O. Davis, MD
1980-81 George Wortzman, MD
1981-82 Gabriel H. Wilson, MD
1982-83 Arthur E. Rosenbaum, MD
1983-84 O. Wayne Houser, MD
1984-85 Samuel M. Wolpert, MD

1985-86 R. Thomas Bergeron, MD
1986-87 Derek C. Harwood-Nash, MD*
1987-88 Michael S. Huckman, MD
1988-89 Anne G. Osborn, MD
1989-90 Joseph F. Sackett, MD
1990-91 Anton N. Hasso, MD, FACP
1991-92 R. Nick Bryan, MD, PhD, FACP
1992-93 David Norman, MD
1993-94 Glenn S. Forbes, MD
1994-95 Robert M. Quencer, MD
1995-96 Robert R. Lukin, MD
1996-97 Burton P. Drayer, MD
1997-98 Richard E. Latchaw, MD
1998-99 A. James Barkovich, MD
1999-00 Eric J. Russell, MD, FACP
2000-01 William S. Ball, Jr., MD
2001-02 William P. Dillon, MD
2002-03 Patrick A. Turski, MD
2003-04 Charles M. Strother, MD
2004-05 Victor M. Haughton, MD
2005-06 Patricia A. Hudgins, MD
2006-07 Robert I. Grossman, MD

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
In Memoriam

J. Arliss Pollock, MD
1933-2007

J. Arliss Pollock, MD, pioneering Sacramento neuroradiologist passed away in October 2007. All neuroradiologists since the inception of the American Society of Neuroradiology (ASNR), in 1962, have benefited from the proactive efforts put forth by Dr. Pollock both in his practice and unending work for the ASNR. A true visionary, he was one of the first physicians specializing in neuroradiology. He promoted cerebral angiography and he offered unique perspective in multiple areas.

Dr. Pollock was born in 1933 and raised by a family of cotton farmers in a small East Texas rural town, attended the University of Texas in Austin in 1954, receiving his Bachelor’s Degree and then his medical degree at the University of Texas Medical Branch in Galveston in 1958. He served four years in the Army at which time he served his medical internship. In 1963, he relocated to Sutter Community Hospital in Sacramento. In 1966, Dr. Pollock’s residency and fellowship training were conducted at the University of California at San Francisco.

Perhaps his greatest contribution was his leadership and willingness to carve out a new presence for the ASNR in the area of socioeconomics. For years, he led the ASNR in health policy efforts that impact neuroradiology practice and assured proper representation of neuroradiology interests at the AMA CPT Editorial Panel Advisory Committee and the Relative Value Scale Update Committee (RUC). These multi-specialty committees create codes for new technologies and procedures and develop values that set the physician reimbursement rates. ASNR is forever indebted to Dr. Pollock’s contribution in the Clinical Practice Committee, Appropriateness, Standards, Guidelines, Government Relations, Utilization, and clinically relevant technology. In 2001, he received the ASNR’s highest award, the Gold Medal for his exceptional leadership and contributions to the society.

In the words of one of his colleagues, Dr. David Seidenwurm, “Arliss was always ahead of the curve”. He saw that a doctor’s responsibility was first to his patient but also organized access to provision of care through the whole population.

Not only did Dr. Pollock lead in his practice and work hard as chairman of the Clinical Practice Committee and lead neuroradiology into the socioeconomic arena, he was a leader in his own community in the Sacramento area. He was a lover of the arts, contributing his time and effort to benefit so many concerns. He was also past president and board member of the Sacramento Metropolitan Chamber of Commerce and the Sacramento Area Commerce and Trade Organization. He was a constant volunteer and fundraiser for entities such as Big Brothers/Big Sisters and the Sacramento Children’s Home. He supported the Sacramento Theatre Company, as a board member and past president of the organization. Dr. Pollock chaired the Ronald Reagan 1980 campaign for president in Sacramento County and actively supported the GOP candidates throughout the state of California.

Dr. Pollock has left a legacy of silent strength and a potent voice for the field of neuroradiology. As a colleague once noted, he was not a man of many words but you always knew that when he had something to say you had better listen. The ASNR, its leadership and staff have been graced with his power and eloquence that will last for many years to come. To his beloved Jeannie Sylvia who he married in 1999, we wish only peace and gentle memories of his important and vital contribution.
In Memoriam

Fred J. Hodges, MD
1922 - 2007

Dr. Fred Jenner Hodges, III—known to all as Ted—died on August 9, 2007, at his home in Webster Groves, Missouri. Ted was born on September 23, 1922, in Madison, Wisconsin.

His love of the medical field came quite naturally, having been born into a family of physicians. His father, Fred Jenner Hodges, II, was professor and chair of the Department of Radiology at the University of Michigan; his uncle, Paul Hodges, was professor and chair of the Department of Radiology at the University of Chicago; and the family’s ancestors include Edward Jenner, who developed the smallpox vaccine.

Ted attended the University of California, Berkeley, and the University of Michigan, Ann Arbor. He received an undergraduate degree and a medical degree from the University of Wisconsin, Madison. He completed an internship at Strong Memorial Hospital in Rochester, New York, and participated in a four year medicine and radiology residency at the University of Michigan, Ann Arbor.

Ted first came to Mallinckrodt Institute of Radiology at Washington University in St. Louis, Missouri in 1957 as an assistant professor. In that same year, Hugh Wilson, the Institute’s director, with the assistance of Torgny Greitz, from Sweden, established the neuroradiology section—one of the first in the United States. Ted was named head of the Institute’s neuroradiology program in 1958.

During his early years at the Institute, Ted received a National Institutes of Health Fellowship in Neuroradiology and spent one year in Gothenburg, Sweden, learning the nuances of this promising subspecialty. He left Mallinckrodt Institute of Radiology in 1966 to become chief of neuroradiology at Johns Hopkins Hospital in Baltimore, Maryland, and returned to Mallinckrodt Institute in 1980 as professor of radiology and co-directed the Institute’s neuroradiology section with Mokhtar Gado. He became professor emeritus in 1993 and officially retired in 2003, closing a career that spanned nearly 6 decades.

Over the years, Ted earned many honors and awards but perhaps none was as dear to his heart as being elected president (1971–1972) of the American Society of Neuroradiology (ASNR). He was highly respected as a reviewer for the American Journal of Neuroradiology (AJNR) and was a charter member of the Association of University Radiologists and of the American Society of Neuroradiology. In 1975, he served on the Panel of Consultants to the Commission on CIA Activities within the United States, reviewing the assassination of President John F. Kennedy. He served for 21 years as a guest examiner for the American Board of Radiology.

Ted served as an attending physician in neuroradiology at St. Louis Children’s Hospitals. Over the course of his 32 years at the Institute, Ted was a patient, enthusiastic, and generous teacher who enriched the careers of numerous fellows, residents, and medical students at Washington University Medical Center.

Ted Hodges was a gifted radiologist, a dedicated teacher, a dear friend to many, and a loving and devoted family man. He will be missed by everyone who was fortunate to have known him. His wife, Genny; two sons, Fred and Thomas; and a brother, John, survive him.
Awards and Honors

2007 - 2008 ASNR Gold Medal Award

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

ASNR 2008 Gold Medal Recipient

Robert R. Lukin, MD

Dr. Robert Lukin was born and raised in Cleveland, Ohio. He matriculated at Ohio State University in 1958, and earned his Bachelor of Science degree in 1961. He was accepted into the University of Cincinnati, College of Medicine in 1961, and graduated Alpha Omega Alpha in 1965. Upon completion of medical school, he was unsure of what medical specialty he wished to pursue, so he performed an internal medicine internship in Cleveland at Mt. Sinai Medical Center. In 1966, he joined the Public Health Service working on a special drug efficacy study under the auspices of the National Academy of Science and the Food and Drug Administration. Then, in 1968, Dr. Ben Felson, Chairman of Radiology at the University of Cincinnati, convinced him that Radiology was the specialty that impacts medicine far more than others, and Dr. Lukin was accepted into their Radiology Residency Program at the University of Cincinnati. Dr. Lukin completed his residency in 1971, and completed his Neuroradiology fellowship in 1972. Dr. Ben Felson and Dr. Jerome Wiot, the Vice Chair, recruited Dr. Lukin, offering him a faculty position.

Dr. Lukin chose Neuroradiology as a subspecialty, because he enjoyed its procedural aspect, e.g., angiograms, myelograms, etc., as well as his belief that this specialty was at the cutting-edge of diagnostic medicine. His foresight proved to be very accurate, when two years later, CT was introduced, and had a major impact on clinical neuroradiology. Dr. Wiot became Chair of Radiology in 1974 and, with Dr. Lukin’s help and support, was able to acquire the first CT scanner in the Ohio-Indiana-Kentucky tri-state area. Dr. Lukin served as Section Head of Neuroradiology from 1972 until 1993, when he accepted the Chairmanship of the Department of Radiology.

For 15 years he oversaw the strong advancement and implementation of imaging techniques, leading the department with his characteristic calm, strong leadership style. He stepped down recently in February of 2008, allowing the bright, eager and younger group of physicians that he had mentored for a number of years to embrace the future. With pride, the University of Cincinnati recognized his contribution as only the third chair of the department, following Drs. Felson and Wiot. He strengthened the tradition of a strong residency program, and expanded the clinical programs and services, assuring that the department was always well equipped with cutting-edge technology. The Radiology Department is one of the strongest departments at the University of Cincinnati Medical Center. His chairmanship provided the underpinning for several successful ventures that have been implemented, and created a vision for the future.

Dr. Lukin served as ASNR Treasurer (1989-1991), Vice President and Program Chair (1994-1995), and President (1995-1996). He considers it a great honor that as President he presented Gold Medal Awards to Drs. Giovanni DiChiro and Sadek K. Hilal. During his tenure, the Clinical Practice Committee was formed, as he was able to persuade Dr. Arliss Pollock to chair the first Clinical Practice Committee, which greatly benefited all members of the ASNR. Subsequently, Dr. Pollock was awarded the ASNR Gold Medal for his efforts. Dr. Lukin’s impact is formidable, as he worked with other society leaders to determine eligibility of non-fellowship trained radiologists interested in taking the new Neuroradiology Certification of Added Qualifications (CAQ) exam. Ultimately, approximately 400 individuals participated in this exam. In 1997, Dr. Lukin was appointed a Trustee of the American Board of Radiology, which resulted in serving once again on ASNR’s Executive Committee (for a total of 17 continuous years, in multiple capacities).

In 1998, and early in Dr. Lukin’s tenure with the ABR, the Maintenance of Certification (MOC) appeared on the horizon for the ABR. This was directed by the American Board of Medical Subspecialties (ABMS), and required the ABR to develop a process of re-certification for radiology. For nearly 8 years, this developmental process required a tremendous amount of time and effort for all ABR trustees. During this time, Dr. Lukin became one of the leaders for all of the radiology subspecialties, but was known particularly for his expertise and strength in Neuroradiology. In his long history of serving the ABR, Dr. Lukin has given the most oral exams of anyone in any specialty. He collaborated with other well-known specialty leaders in preparing the written board exams for Radiology over a period of 9 years, and was responsible for the oral ABR resident exam, the CAQ exam, and the CAQ recertification exam.

With characteristic humility, Dr. Lukin considers himself primarily a clinician and educator, and is very proud that he has taught Neuroradiology to over 300 residents and 60 fellows.

People who know Dr. Lukin and Marcia, his wife of 46 years, understand their pride and happiness with their three children and four grandchildren.
## Awards and Honors

### Past ASNR Gold Medal Award Recipients

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<tr>
<th>Year</th>
<th>Recipients</th>
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<tbody>
<tr>
<td>1995</td>
<td>Juan M. Taveras, MD*&lt;br&gt; T. Hans Newton, MD</td>
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<td>1996</td>
<td>Sadek K. Hilal, MD*&lt;br&gt; Giovanni Di Chiuro, MD*</td>
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<tr>
<td>1997</td>
<td>Derek C. Harwood-Nash, MB, ChB., DSc, FRCP, FCRAD(SA)*</td>
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<td>1998</td>
<td>Irvin I. Kricheff, MD&lt;br&gt; D. Gordon Potts, MD</td>
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<td>1999</td>
<td>Grant B. Hieshima, MD&lt;br&gt; Michael S. Huckman, MD</td>
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<td>2000</td>
<td>Hillier L. “Bud” Baker, Jr., MD</td>
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<td>2001</td>
<td>O. Wayne Houser, MD&lt;br&gt; J. Arliss Pollock, MD*</td>
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<td>2002</td>
<td>R. Thomas Bergeron, MD&lt;br&gt; David O. Davis, MD</td>
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<td>2003</td>
<td>Norman E. Leeds, MD, FACR&lt;br&gt; Anne G. Osborn, MD, FACR</td>
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<td>2004</td>
<td>Ralph Heinz, MD, FACR&lt;br&gt; Stephen A. Kieffer, MD, FACR</td>
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<td>2005</td>
<td>Samuel M. Wolpert, MD</td>
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<td>2006</td>
<td>R. Nick Bryan, MD, PhD, FACR&lt;br&gt; Charles W. Kerber, MD</td>
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<td>2007</td>
<td>Robert M. Quencer, MD</td>
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### Past ASNR Honorary Member Recipients

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<tr>
<th>Year</th>
<th>Recipients</th>
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<tr>
<td>2008</td>
<td>There is no Honorary Member in 2008.</td>
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</tbody>
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### Past ASNR Honorary Member Recipients (2008-2002)

- **2008**<br> Michael Radford Sage, MD, FRANZCR, FCR, FRCPC (Lon), FRCP (Ed), FHKCR (Hon)
- **2007**<br> Georges Salamon, MD<br> George Schuyler<br> S. I. Seldinger, MD<br> Fjodor Serbinenko, MD<br> Mutsumasa Takahashi, MD<br> Galdino E. Valvassori, MD<br> Marjo S. van der Knaap, MD<br> Prof. Prof. Jacqueline Vignaud<br> M. Gazi Yasargil, MD<br> Ian R. Young, BSc, PhD
- **2006**<br> Pierre Lasjaunias, MD, PhD<br> Paul C. Lauterbur, PhD*<br> Dennis LeBihan, MD, PhD<br> Marco Leonardi, MD<br> Erik Lindgren, MD<br> Claude H. Manelfe, MD<br> Professor Luc Picard<br> Michel Ter Pogossian, MD*<br> Joseph Ransohoff, MD*<br> Jesus Rodriguez-Carbajal, MD<br> Lee F. Rogers, MD<br> Prof. Lucy Balian Rorke
- **2005**<br> Torsten Almen, MD<br> James W. Bull, MD*<br> Graeme M. Bydder, MD, ChB<br> M. Paul Capp, MD<br> Sten Cronqvist, MD*<br> B. G. Ziedes des Plantes, MD*<br> George du Boulay, MD*<br> Richard R. Ernst, MD<br> Torgny V. B. Greitz, MD<br> Godfrey N. Hounsfield, PhD*<br> Yun Peng Huang, MD<br> Ian Isherwood, MD

*deceased
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.

2008 NER Foundation Award for Outstanding Contributions in Research

A. James Barkovich, MD

A. James Barkovich, MD, is a professor of Radiology, Neurology, Pediatrics, and Neurosurgery at the University of California at San Francisco, where he has worked since 1986. Dr. Barkovich combines a busy clinical practice with an active research program, which centers on the use of neuroimaging to assess normal and abnormal brain development. Dr. Barkovich has used his interest in brain development to delve into genetic and acquired mechanisms by which brain development goes awry, both in utero and after birth. This has led to his pioneering work in MR imaging of the fetal and neonatal brain, as well as his extensive work in the correlation of genetics and embryology with the morphology and classification of brain malformations. The NIH has funded Dr. Barkovich for more than 15 years, both as a principal investigator and as co-investigator of multiple R01, R21, and program project grants dealing with neonatal brain injury, epilepsy, and brain malformations. He leads a large multidisciplinary group that includes radiologists, MR scientists, neonatologists, neurologists, geneticists, and neuroscientists. Dr. Barkovich’s publications include more than 270 peer-reviewed scientific papers, 20 invited editorials, 21 invited review articles, 33 book chapters, 5 authored textbooks, and 3 edited/partially authored textbooks.

Currently, Dr. Barkovich’s research group is involved in developing new coils and methods for optimal neonatal and fetal brain imaging, studying the effects of premature birth on development of the cerebral cortex, cerebellum, brain stem, and white matter pathways, and correlating brain development in fetuses and similarly aged premature neonates. Techniques involved include 3D MRf, applications of advanced diffusion imaging techniques in tractography, and BOLD imaging of changes in resting state functional connectivity with brain maturity. Dr. Barkovich also collaborates on grants with research groups in other cities, such as Boston and Chicago, to investigate genetic disorders of brain development.

Past Award Recipients:

2007 Clifford R. Jack, Jr., MD
2006 No Award Given
2005 Dixon M. Moody, MD, FACR
2004 Robert I. Grossman, MD
Awards and Honors

ASNR 2007 Outstanding Presentation Awards

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

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

General Neuroradiology

PAPER 16: Acquisition of 7T 3D MRS Imaging Data from Patients with Brain Tumors
Nelson, S.J.1 • Xu, D.1 • Hammond, K.E.1 • Lupo, J.1 • Chen, A.1 • Kelley, D.A.2 • Vigneron, D.B.1
1University of California San Francisco, San Francisco, CA
2GE Healthcare, San Francisco, CA

Bayer Best Paper Award in General Neuroradiology

PAPER 9: 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

Interventional Neuroradiology

(The Michael Brothers Memorial Award)

Paper 328: Factors Associated with Wall Enhancement and Edema after Endovascular Coiling of Cerebral Aneurysms
Fanning, N.F. • Willinsky, R.A. • terBrugge, K.G.
Toronto Western Hospital, Toronto, Ontario, Canada

Pediatric Neuroradiology

(The Derek Harwood-Nash Award)

PAPER 209: Alterations in Regional Oxygen Saturation (StO2) and Cerebral Blood Volume in NICU Babies
Grant, P.E. • Krishnamoorthy, K.S. • Selb, J. • Barnett, S. • Warren, E. • Franceschini, M.
Massachusetts General Hospital, Boston, MA

Spine

PAPER 161: Ex vivo Diffusion Tensor Imaging of the Spinal Cord following Cervical Hemi-Contusion Injury
Schwartz, E.D.1 • Stackhouse, S.2 • Hsu, O.3 • Sandrow, H.R.2 • Shumsky, J.S.2
1University of Pittsburgh Medical Center, Pittsburgh, PA
2Drexel University College of Medicine, Philadelphia, PA
3University of Pennsylvania School of Medicine, Philadelphia, PA

Awards and Honors

2007/2008 Specialty/Regional Society Awards

The American Society of Neuroradiology is pleased to announce the recipients of the 2007/2008 Special/Regional Society Awards. These individuals were selected by the respective societies as having the best presentation at each society’s most recent Annual Meeting.

American Society of Spine Radiology (ASSR) Mentor Award
“Combination of IDEAL and ARC Imaging to Obtain Homogeneous Fat Saturation in the Brachial Plexus within Clinically Acceptable Time Parameters”
Dr. Allison M. Grayev
University of Wisconsin, Madison, WI

Southeastern Neuroradiological Society (SENRS)
“Imaging Follow Up of Endovascularly Treated Aneurysms: Who, How and When”
Dr. Mary E. Jensen
University of Virginia, Charlottesville, VA

Eastern Neuroradiological Society (ENRS)
(The Norman E. Leeds Award)
“Perfusion Imaging in Brain Tumors: Value of Perfusion Cerebral Blood Volume Measurements in Predicting Time to Progression/Outcome in Gliomas Compared with Histopathologic Assessment”
Dr. Robert J. Young
Memorial Sloan-Kettering Cancer Center, New York, NY

Western Neuroradiological Society (WNRS)
(The Gabriel H. Wilson Award)
“Postradiation Treatment Effects vs Tumor Recurrence: Direct Correlation between Histopathology and Perfusion MR Imaging Measurements”
Dr. Leland S. Hu
Barrow Neurological Institute/St. Joseph’s Hospital, Phoenix, AZ
Awards and Honors
2008-2009 Bayer Healthcare Pharmaceuticals, Inc./NER Foundation Fellowship in Basic Science Research Awards

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

The recipients of the 2008-2009 fellowships are:

**Bradley Foerster, MD**
Johns Hopkins Hospital, Baltimore, Maryland
“MR Molecular Imaging of Glutamate Carboxypeptidase II (GCPII) Modulation in an Experimental Model of Stroke”

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

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 Fullbright, 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”

Awards and Honors
2008-2009 Bayer Healthcare Pharmaceuticals, Inc./NER Foundation Fellowship in Basic Science Research Awards

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“Diffusion Tensor Imaging in the Identification of the Extra-Hippocampal Abnormality in the Patients with Mesial Temporal Lobe Epilepsy with Hippocampal Sclerosis”
Awards and Honors (Continued)
Past Bayer Healthcare Pharmaceuticals, Inc./NER Foundation Fellowship in Basic Science Research Awards

<table>
<thead>
<tr>
<th>Year</th>
<th>Name</th>
<th>Institution</th>
<th>Research Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996-97</td>
<td>Joseph T. Lurito, MD, PhD</td>
<td>The Johns Hopkins Hospital</td>
<td>&quot;Functional MRI and Electrophysiologic Correlates of Sub-modality Specific Somatosensory Activation&quot;</td>
</tr>
<tr>
<td></td>
<td>Jeffrey L. Sunshine, MD</td>
<td>University Hospitals of Cleveland</td>
<td>&quot;Early Identification of Ischemic Penumbra by Diffusion and Perfusion MR in Acute Stroke&quot;</td>
</tr>
<tr>
<td>1997-98</td>
<td>Huy M. Do, MD</td>
<td>University of Virginia Health Sciences Center</td>
<td>&quot;The Neuroprotective Effect of Intravenous Nerve Growth Factor (HGF) in a Rabbit Embolic Stroke Model&quot;</td>
</tr>
<tr>
<td>1998-99</td>
<td>William F. Marx, MD</td>
<td>University of Virginia</td>
<td>&quot;Endovascular Treatment of Experimental Aneurysms Using Biologically Modified Embolic Coils: Promotion of Permanent Occlusion via Intraneurysmal Fibroblast Delivery&quot;</td>
</tr>
<tr>
<td>1999-00</td>
<td>Kevin R. Moore, MD</td>
<td>University of Utah Center for Advanced Medical Technology</td>
<td>&quot;Meg-Constrained High-Resolution Surface-Coil MR Imaging and MR Spectroscopy for Evaluating Medically Refractory Epilepsy&quot;</td>
</tr>
<tr>
<td></td>
<td>John G. Short, MD</td>
<td>University of Virginia</td>
<td>&quot;Induction of Spinal Interbody Fusion Using Gene Therapy Tissue Engineering Techniques&quot;</td>
</tr>
<tr>
<td>2000-01</td>
<td>John Port, MD, PhD</td>
<td>The Johns Hopkins Medical Institution</td>
<td>&quot;Imaging Selective Attention Mechanisms&quot;</td>
</tr>
<tr>
<td></td>
<td>Eric Schwartz, MD</td>
<td>Hospital of the University of Pennsylvania</td>
<td>&quot;Diffusion-based MR Imaging in a Rat Spinal Cord Following Injury and Transplantation&quot;</td>
</tr>
<tr>
<td>2001-02</td>
<td>Pratik Mukherjee, MD, PhD</td>
<td>Mallinckrodt Institute of Radiology, Washington University School of Medicine</td>
<td>&quot;Comparison of Magnetic Resonance Imaging and Positron Emission Tomography in the Study of Cerebral Hemodynamics&quot;</td>
</tr>
<tr>
<td>2002-03</td>
<td>John G. Dalle, DO</td>
<td>University of Utah School of Medicine</td>
<td>&quot;Polymer-Chelate Conjugates for Diagnostic Cancer Imaging&quot;</td>
</tr>
<tr>
<td></td>
<td>Christopher Lascola, MD, PhD</td>
<td>Duke University Medical Center</td>
<td>&quot;Magnetic Resonance Imaging of Spreading Depression-Induced Reactive Gliosis in Mice&quot;</td>
</tr>
<tr>
<td>2003-04</td>
<td>Dheeraj Gandhi, MD</td>
<td>University of Michigan Health System</td>
<td>&quot;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&quot;</td>
</tr>
<tr>
<td></td>
<td>Susan M. Kealey, MD</td>
<td>Duke University Medical Center</td>
<td>&quot;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&quot;</td>
</tr>
<tr>
<td>2004-05</td>
<td>Tuong H. Le, MD, PhD</td>
<td>University of California, San Francisco</td>
<td>&quot;Structural and Functional Correlates of Axonal Shearing in Traumatic Brain Injury: A Combined DTI, fMRI and MSI Study&quot;</td>
</tr>
<tr>
<td></td>
<td>Whitney B. Pope, MD, PhD</td>
<td>David Geffen School of Medicine at University of California, Los Angeles</td>
<td>&quot;Identification of Unstable Atherosclerotic Plaque at the Carotid Bifurcation Using High-Resolution CT-PET Imaging: Correlation to Histopathology and Patient Symptoms&quot;</td>
</tr>
<tr>
<td>2005-06</td>
<td>Srinivasan Mukundan, Jr., PhD, MD</td>
<td>Duke University Medical Center</td>
<td>&quot;Morphometric and Functional Characterization of Atherosclerotic Plaque at the Carotid Bifurcation Using High-Resolution CT-PET Imaging: Correlation to Histopathology and Patient Symptoms&quot;</td>
</tr>
<tr>
<td></td>
<td>Max Wintermark, MD</td>
<td>University of California, San Francisco</td>
<td>&quot;In Vivo Imaging of the Epidermal Growth Factor Receptor with a Bimodal MRI/Optical Contrast Agent&quot;</td>
</tr>
<tr>
<td>2006-07</td>
<td>Michelle S. Bradbury, MD, PhD</td>
<td>Memorial Sloan Kettering Cancer Center</td>
<td>&quot;In Vivo Monitoring of Human Embryonic Stem Cell-derived Grafts in the Central Nervous System of Living Animals Using Optical Imaging Technologies&quot;</td>
</tr>
<tr>
<td></td>
<td>Edwin Wang, MD</td>
<td>New York University School of Medicine</td>
<td>&quot;In Vivo Imaging of the Epidermal Growth Factor Receptor with a Bimodal MRI/Optical Contrast Agent&quot;</td>
</tr>
<tr>
<td>2007-08</td>
<td>Myria Petrou, MA, MBChB</td>
<td>University of Michigan, Ann Arbor, MI</td>
<td>&quot;Investigation of Axonal Loss, Demyelination and Response to Treatment in a Mouse Model of Multiple Sclerosis Using Diffusion Tensor Imaging&quot;</td>
</tr>
<tr>
<td></td>
<td>Elysa Widjaja, MD</td>
<td>Hospital for Sick Children, Toronto, Canada</td>
<td>&quot;Determining the Extent of Diffusion Tensor Abnormalities in Focal Cortical Dysplasia&quot;</td>
</tr>
</tbody>
</table>
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 recipients of the 2008 award are:

Tammie L. S. Benzinger, MD, PhD
Washington University School of Medicine, St. Louis, Missouri
“Childhood leukodystrophy with neuromuscular disability: Translational use of MRI directional diffusivity as a tool for prognosis and response to therapy”

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

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 of Wide Necked Aneurysms”

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

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

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”

2006
Erin Simon Schwartz, MD
Children’s Hospital of Philadelphia, Neuroradiology, Philadelphia, PA
“A Comprehensive MR Assessment of Fetal Physiologic Well-Being”

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

The recipients of the 2008 award are:

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Awards and Honors

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

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

No award in 2008.

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

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

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

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

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

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

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

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

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

Awards and Honors

2007-2008 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.

The recipient of the 2007-2008 fellowship is:
Humberto Morales, MD
University of Cincinnati, Cincinnati, Ohio
“Safety of Iodinated Contrast Material in a Middle Cerebral Artery Occlusion/Reperfusion Model”

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

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

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

2008 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.

No award in 2008.
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”

1987
No Award

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

1989
Allen D. Elster, MD

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

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

1992
R. Gilberto Gonzalez, MD
“Quantitative In Vivo Human Brain Lithium Magnetic Resonance Spectroscopy”

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
“MRI 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”

1998
No Award

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

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

2001
No Award

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

2003
No Award

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

2005
No Award

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

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

2008
No Award
Continuing Medical Education (CME)

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

An enhancement of the Continuing Medical Education online evaluation system allows for attendees to print out their official CME certificate for the number of hours claimed during the NER Foundation Symposium 2008 and ASNR 46th 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 2008 and ASNR 46th Annual Meeting CME Certificate.

Following the meeting, the ASNR 2008 CME certificate site will be available online by mid-July for 90 days for attendees to print out their CME certificates.

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

Letter of Attendance

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

CME Pavilion

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

Please Note: To receive CME credit for sessions attended at the NER Foundation Symposium 2008 and ASNR 46th Annual Meeting, all evaluations must be entered by the end of the meeting.

Scientific Program and Meeting Evaluation

The 2008 Continuing Medical Education (CME) Pavilion allows online recording of CME credits via the Internet. The improvements have created a faster and more user-friendly system for evaluating sessions and speakers and recording CME hours electronically.

The CME Pavilion is easily accessible in Room 203 and in Hall A at the Ernest N. Morial Convention Center. Please complete the evaluations for each session to assist in planning future meetings and to help us maintain accreditation of future programs.

Accreditation Statement

The American Society of Neuroradiology is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. The American Society of Neuroradiology takes responsibility for the content, quality, and scientific integrity of the CME activity. The American Society of Neuroradiology designates this educational activity for 32.75 of AMA PRA Category 1 Credit(s)™. Physicians should claim credit commensurate with the extent of their participation in the activity.

Target Audience

The ASNR 46th 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 46th Annual Meeting Educational Objectives

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

**General Programming**
- Identify the use of imaging as biomarkers and surrogates for assessment of new treatments of brain neoplasms.
- Utilize advanced imaging techniques for detection and characterization of effects of minor head trauma.
- Review important practice issues in neuroradiology including: Patient centered radiology; Pay for performance and Practice improvement – PQRI.
- Interpret the “state of the art” of Intraoperative and interventional imaging equipment and the role of diagnostic neuroradiologist in the performance and interpretation of images generated in the OR and interventional suite.
- Distinguish the diagnostic features and work up of thyroid lesions.
- Develop expertise in the performance and interpretation of brain perfusion MR and CT studies.
- Identify the imaging features of mitochondrial cytopathies in pediatric stroke.
- Apply and learn the work up and diagnostic features of motor cranial neuropathies.
- Identify the pitfalls of PET/CT.
- Define the use of fMRI in presurgical planning.
- Review the natural history of arteriovenous malformations, their diagnosis and treatment.

**Advanced Imaging Programming**
- Discuss the various Advanced Clinical Applications in DTI and identify Clinical and Advanced MEG Methods.
- Define advances in Sodium Imaging.
- Review the Advances in Arterial Spin Labeling and Sodium Imaging.
- Discuss Cell Tracking in Molecular Imaging: MRA Flow Techniques and High Field Spinal Cord DTI.
- Review of Diffusion MRI of Neural Networks and Functional Connectivity.

**Neurointerventional Programming**
- Demonstrate the utility of aneurysm flow modeling for pretreatment planning.
- Review appropriate imaging paradigms to follow patients after endovascular aneurysm therapy.
- Discuss the natural history of cerebral AVMs.
- Outline characteristics for goal oriented endovascular AVM therapy.
- Review imaging techniques for brain attack patient triage.
- Discuss literature based evidence for intracranial angioplasty/stenting.

**Spine Programming**
- Review cutting-edge imaging techniques for evaluating the spine, including introducing a novel pattern-recognition approach to spinal cord lesions.
- Discuss the workup and treatment of the patient with back pain, including physical examination techniques and applications and technical aspects of fluoroscopic and CT-guided interventional spine procedures for diagnosis and pain management.
- Review the acquisition and analysis of various diagnostic imaging modalities, and treatment approaches, for the management of scoliosis.

**Head and Neck Programming**
- Detect signs of orbital-ocular emergencies of traumatic and non-traumatic etiology.
- Identify head and neck emergencies in the adult and pediatric patient populations including acute face and neck swelling.
- Detect pediatric temporal bone emergencies.
- Review craniofacial trauma and identify key findings that the surgeon needs to know and why such information is important.
- Review the pediatric skull base and associated pathologies.
- Review the cranial nerves including motor cranial neuropathies and complex multiple cranial neuropathies.
- Discuss head and neck neoplasms in childhood.
- Describe laryngeal and nasopharyngeal anatomy and patterns of cancer spread.
- Identify challenges in imaging the post-treatment head and neck oncology patient.
- Describe pitfalls in sinonasal imaging.

**Functional Programming**
- Explore the perspectives of neuroradiologists and neurosurgeons concerning the clinical utility of blood oxygen level dependent (BOLD) functional imaging.
- Explore the role of BOLD motor and language functional mapping and complementary role of state of the art vascular reactivity imaging in the preoperative risk assessments of patients with brain tumors.
- Demonstrate the clinical utility of diffusion tensor imaging for delineation of eloquent white matter tracts.
- Review current understanding regarding the role of magnetoencephalography (MEG) in clinical presurgical mapping.
- Explore the roles of high field MRI in the imaging of cellular probes, molecular and biomarker imaging in neurosciences, and molecular neuroimaging in the evaluation and management of brain tumors.
- Explore the increasing clinical relevance of molecular imaging as it relates to the future practice of neuroradiology.
- Examine the economic issues related to clinical functional imaging and its reimbursement.

**Pediatric Programming**
- Discuss the genetic basis of pediatric neurologic diseases.
- Identify the levels of heart-brain connectivity in pediatric neurologic disorders.
- Identify the neurologic, pathologic and radiologic basis of pediatric epilepsy.

**Maintenance of Certification (MOC) Programming**
- Identify imaging features of common and unusual cerebrovascular disease presenting to the emergency department.
- Classify congenital anomalies of the spine.
- Identify the features that define inflammatory lesions of the head and neck and their differentiation from neoplastic masses.
- Identify the imaging features of traumatic lesions of the brain and spine.
- Interpret familiar treatment options for cerebral infarction.
Electronic Learning Center 2008 Workshops

ELC Workshops - Room 204/205

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 2007 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 2 □ 10:45am – 12:15pm
Monday, June 2 □ 3:30pm – 5:00pm

John L. Go, 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. The participant will learn how lecture material can be developed for display using digital projectors. Learning Objectives of this workshop include: creating a new presentation from scratch, using the presentation assistants, copying, deleting and modifying the sequence of slides, working with Clip Art, inserting 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: Adobe Photoshop and Elements

Monday, June 2 □ 1:30pm – 3:00pm
Tuesday, June 3 □ 1:30pm – 3:00pm

Andrew Ku, 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; rewindowing and leveling; cropping and removing extraneous text and markings; and converting to grayscale. Attendees will also use the more common graphics tools such as airbrush, blur, rubber stamp, eyedropper, magic wand, paint bucket, and others.

ELC Workshop C: Advanced PowerPoint

Monday, June 2 □ 5:00pm – 6:30pm
Tuesday, June 3 □ 10:45am – 12:15pm
Wednesday, June 4 □ 1:15pm – 2:45pm

Barton F. Branstetter IV, MD
H. Christian Davidson, 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 D: Advanced Web Design

Wednesday, June 4 □ 5:00pm – 6:30pm

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.
**ELC Lecture A: Speech Recognition**

**Tuesday, June 3 | 5:00pm – 6:00pm**

*Barton F. Branstetter IV, MD*

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.

**ELC Lecture B: PACS and RIS 2008: An Update**

**Tuesday, June 3 | 3:30pm – 4:30pm**

*C. Douglas Phillips, MD, FACR*

*Richard H. Wiggins, III, MD*

These lectures will give the attendee an advanced look at PACS and RIS. The first lecture will describe recent PACS advances and important issues including hardware and software integration, such as the incorporation of 3D laboratory work within PACS (as opposed to freestanding workstations), the PACS as the RIS, advanced imaging manipulations, volume depiction and reporting, PACS as the transcription tool, and computer-assisted diagnoses. The second lecture will discuss more advanced issues, such as other system integration issues and database migration. There are several options for an institution after outgrowing or just outliving a 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.

**ELC Lecture C: MRI Safety**

**Wednesday, June 4 | 3:30pm – 4:30pm**

*Ulrich A. Rassner, MD*

This workshop will discuss the following aspects of magnetic resonance (MR) safety. MR safety remains a paramount concern in the operation of a MR scanner. The most serious emergencies in MR scanners usually arise from the interaction of the static magnetic field with ferromagnetic objects. The lack of familiarity of non-MR-personnel with safety aspects of MRI poses a particular risk. In some emergencies an emergency shutdown or even a quench might be required. In daily operation, the FDA guidelines provide limitations for exposure to static and gradient fields as well as energy deposited by radiofrequency pulses. Medical devices significantly add to the complexity of safely operating a MR scanner. After reviewing medical device testing and the terminology in device labeling, some commonly encountered devices and the effect of field strength will be discussed. Recently, a new safety concern has arisen from the effects of gadolinium agents in renal failure patients and development of nephrogenic systemic fibrosis (NSF). Current guidelines will be reviewed.
Synopsis: The ASNR Business Center will offer executive lectures encompassing topics pertinent to management and administration for both private practice and academic departments.

Goals: We will discuss into topics involving Patient-Centered Radiology from both the customer and Radiologist perspectives. For the former, patient and referring physician service expectations will be discussed as well as mechanisms and approaches for addressing them.

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.

Monday, June 2, 2008 - Day 1

1:30pm - 1:45pm

“Introduction: Quality Throughout”
Gregory L. Katzman, MD, MBA
Professor and Chairman, University of Texas Medical Branch
We will provide an overview on the topic of “quality” as it impacts Radiology. In some instances, “quality” is a true measure of our productivity, whereas in others it becomes merely a fig leaf for cost and utilization scrutiny. Regardless, “quality” is upon us and the sooner we comprehend its ramifications the better prepared we will be to work them to our advantage.

1:45pm - 2:30pm

“Patient Centered Radiology”
Frank J. Lexa, MD, MBA
Professor, Wharton Graduate School of Business
Clinical Professor, University of Pennsylvania
Commoditization is one of the greatest threats to the practice of radiology in the digital age. One important way for diagnostic imaging practices to differentiate themselves and avoid becoming low-cost commodity providers is by re-focusing on the needs of patients as our key customers. This lecture will discuss both the opportunities and hazards of this shift in practice and what changes are required to succeed at patient-centered radiology service.

2:30pm - 3:00pm Discussion

3:00pm - 3:25pm Afternoon Break

3:30pm - 4:15pm

“Reinventing Radiology”
Fred Gaschen, MBA
Radiological Associates of Sacramento Medical Group, Inc.
In 2008, being an aware private practice radiologist means feeling under attack, whether from payers, the latest Deficit Reduction Act or your previously loyal referring clinicians. Increasingly, being a forward thinking radiologist means reinventing your job description. This talk will describe ways to look beyond your traditional concept of imaging.

4:15pm - 5:00pm

“Patients or Consumers? Medicine in the 21st Century”
Andrew F. Simon, PhD, PsyD
Seton Hall University
Physicians are currently facing dilemmas not seen before in the practice of medicine. The abundance of (mis-)information that is easily available through the Internet and other popular sources has placed physicians in a precarious position. Patients still turn to doctors for answers; but doctors now have to interact with overconfident consumers who challenge medical expertise with inaccurate information. Optimal treatment now includes educating patients and considering their need for personalized information as part of treatment.
How-To Sessions  (As of 04/17/08)

In addition to the Technical Exhibition, the leadership of the ASNR is pleased to announce the twelfth annual slate of instructional How-To forums. These sessions, presented in conjunction with major corporate contributors, deal with advances in imaging and procedures as well as principles in neuroradiology and image information management. How-To Breakfast and Lunch Sessions are scheduled throughout the week.

The How-To Sessions offer a unique opportunity for neuroradiologists to discuss techniques, procedures, and products with their colleagues as well as with technical specialists from the imaging industry. Comments and suggestions from meeting registrants over the last nine years were integrated into this year’s format.

The sessions vary and include both didactic presentations and demonstrations, all with a strong practical emphasis. A significant portion of each session is devoted to questions and answers.

Tuesday, June 3 .................................12:30 pm - 1:30 pm
“Recent Advances in CT Perfusion: Applications in Neurovascular Disease.”
Dheeraj Gandhi, MD

Wednesday, June 4 .................................12:30 pm - 1:30 pm
“Introducing Signa MR750 3.0T for Neuro MRI: Simply Powerful and Powerfully Simple.”
Aaron S. Field, MD, PhD

Monday, June 2 .................................6:30 am - 7:30 am
“Are There Real Differences among the Gadolinium Agents for Contrast Enhanced Neuroimaging?”
Howard A. Rowley, MD

“Contrast Media Use at 3T: Practical Tips and Protocols for the Neuroradiologist.”
David Enterline, MD

“Safety Update on MR Contrast Use in Patients with Chronic Kidney Disease - What You Need to Know.”
Emanuel Kanal, MD

Sunday, June 1 .................................12:30 pm - 1:30 pm
“Programming To Be Determined.”

Monday, June 2 .................................6:30 am - 7:30 am
“Neurovascular and Acute Stroke Applications with Aquilion One Dynamic Volume CT.”
Kieran P.J. Murphy, MD, FRCPC

PLEASE NOTE: Due to the direct financial support from these companies and the commercial content, CME credit will not be granted for these sessions.
Printed and Electronic Scientific Exhibits (eSE)

Hall B1, Street Level

**Scientific Exhibits**
- Adult Brain: 1-26
- Anatomy: 27
- Head and Neck: 28-40
- Interventional: 41-43
- Pediatrics: 44-48
- Spine: 49-57

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

Shared eSE Presentations 1-33, 35-87 can be accessed from any shared eSE computer. eSE Presentation 34 can be accessed on the assigned computer only.
## Scientific Posters (As of 04/17/08)

**Hall B1, Street Level**

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### Scientific Posters

- Adult Brain: 1-140
- Anatomy: 141-144
- Head and Neck: 145-150
- Interventional: 151-178
- Pediatrics: 179-194
- Socioeconomic: 195-196
- Spine: 197-211

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

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| P15 | P16 | P44 | P45 | P72 | P73 | P100 | P101 | P129 | P130 | P157 | P158 | P185 | P186 |
|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|
| P14 | P17 | P43 | P46 | P71 | P74 | P99  | P102 | P128 | P131 | P156 | P159 | P184 | P187 |
| P13 | P18 | P42 | P47 | P70 | P75 | P98  | P104 | P127 | P132 | P155 | P160 | P183 | P188 |
| P12 | P19 | P41 | P48 | P69 | P76 | P97  | P105 | P126 | P133 | P154 | P161 | P182 | P189 |
| P11 | P20 | P40 | P49 | P68 | P77 | P96  | P106 | P125 | P134 | P153 | P162 | P181 | P190 |
| P10 | P22 | P39 | P50 | P67 | P78 | P95  | P107 | P124 | P135 | P152 | P163 | P180 | P191 |
| P9  | P23 | P38 | P51 | P66 | P79 | P94  | P108 | P123 | P136 | P151 | P164 | P179 | P192 | P207 | P208 |
| P8  | P24 | P37 | P52 | P65 | P80 | P93  | P109 | P122 | P137 | P150 | P165 | P178 | P193 | P206 | P209 |
| P7  | P25 | P36 | P53 | P64 | P81 | P92  | P110 | P121 | P138 | P149 | P166 | P177 | P194 | P205 | P210 |
| P6  | P26 | P35 | P54 | P63 | P82 | P91  | P111 | P120 | P139 | P148 | P167 | P176 | P195 | P204 | P211 |
| P5  | P27 | P34 | P55 | P62 | P83 | P90  | P112 | P119 | P140 | P147 | P168 | P175 | P196 | P203 |
| P3  | P28 | P33 | P56 | P61 | P84 | P89  | P113 | P118 | P141 | P146 | P169 | P174 | P197 | P202 |
| P2  | P29 | P32 | P57 | P60 | P85 | P88  | P114 | P117 | P142 | P145 | P170 | P173 | P198 | P201 |
| P1  | P30 | P31 | P58 | P59 | P86 | P87  | P115 | P116 | P143 | P144 | P171 | P172 | P199 | P200 |

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XXXII
Technical Exhibits (As of 04/17/08)

Ernest N. Morial Convention Center - Hall A

Tuesday, June 3 ..........................................................................................................................10:15 am – 4:00 pm
Tuesday, June 3 - Reception .................................................................................................6:30 pm – 8:00 pm (Hall A)
Tuesday, June 3 - Reception .................................................................................................8:00 pm – 9:00 pm (La Louisiane Ballroom)
Wednesday, June 4..................................................................................................................10:20 am – 4:00 pm
Thursday, June 5 ........................................................................................................................10:00 am – 4:00 pm

American Society of Neuroradiology and NER Foundation ......................................................Booth 519
2210 Midwest Road, Suite 207
Oak Brook, IL 60523

Concentric Medical, Inc. ........................................Booth 101
301 East Evelyn Avenue
Mountain View, CA 94043

4-D Neuroimaging ..................................................................................................................Booth 200
9727 Pacific Heights Boulevard
San Diego, CA 92121

Cordis Neurovascular, Inc. ................................Booth 100
14201 NW 60th Avenue
Miami Lakes, FL 33014

Advanced Imaging Research, Inc. ................................Booth 216
4700 Lakeside Avenue, Suite 400
Cleveland, OH 44141

Elsevier Saunders & Mosby Publishers ..........Booth 400
POB 360446
Birmingham, AL 35236

American Medical Recruiters ................................Booth 107
6400 N Andrews Avenue, #100
Ft. Lauderdale, FL 33309

GE Healthcare...................................................Booth 317
3000 N. Grandview Boulevard
Waukesha, WI 53188

Amirsys Inc. .................................................Booth 301
2180 South 1300 East
Suite 405
Salt Lake City, UT 84106

Hitachi MR and Diagnostic Imaging Systems ......Booth 401
1959 Summit Commerce Park
Twinsburg, OH 44087

ArthroCare Corporation ..................................Booth 202
680 Vaqueros Avenue
Sunnyvale, CA 94085

Invivo .................................................................Booth 402
12601 Research Parkway
N27 W23676 Paw Rd
Pewaukee, WI 53072

Bayer Healthcare Pharmaceuticals ....................Booth 501
6 West Belt
Wayne, NJ 07470

Kyphon, Inc. ....................................................Booth 417
MEDTRONIC
1221 Crossman Avenue
Sunnyvale, CA 94089

Boston Scientific Neurovascular ....................Booth 201
47900 Bayside Parkway
Fremont, CA 94538

Lippincott Williams & Wilkins .........................Booth 208
110 Kramer Court
Mandeville, LA 70471

Bracco Diagnostics Inc. ....................................Booth 306
107 College Road East
Princeton, NJ 08540

MicroVention, Inc. ............................................Booth 406
75 Columbia, Suite A
Aliso Viejo, CA 92656

Cardinal Health ................................................Booth 108
1450 Waukegan Road
McGaw Park, IL 60085

Medis Medical Imaging Systems Inc. ............Booth 203
751 Miller Drive, Suite D2
Leesburg, VA 20175
<table>
<thead>
<tr>
<th>Company</th>
<th>Booth</th>
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<tbody>
<tr>
<td>MEDRAD, Inc.</td>
<td>106</td>
<td>One Medrad Drive, Indianola, PA 15051</td>
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<tr>
<td>Micrus Endovascular</td>
<td>207</td>
<td>821 Fox Lane, San Jose, CA 95131</td>
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<tr>
<td>Minsurg Corporation</td>
<td>117</td>
<td>112 N. East St, Suite C, Tampa, FL 33602</td>
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<td>Neurognostics</td>
<td>316</td>
<td>10437 Innovation Drive, Milwaukee, WI 53226</td>
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<td>NeuroLogica Corporation</td>
<td>307</td>
<td>14 Electronics Avenue, Danvers, MA 01923</td>
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<td>Nfocus Neuromedical</td>
<td>517</td>
<td>2191 East Bayshore Road, Suite 100, Palo Alto, CA 94030</td>
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<tr>
<td>NordicImagingLab</td>
<td>109</td>
<td>Moellendalsveien 65C, Bergen, Norway N-5009</td>
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<tr>
<td>Philips Healthcare</td>
<td>507</td>
<td>33 Thompson Hill Road, Milford, CT 06460</td>
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<tr>
<td>Prism Clinical Imaging, Inc.</td>
<td>102</td>
<td>851 South 70th Street, Suite 103, West Allis, WI 53214</td>
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<tr>
<td>Radius Medical, LLC</td>
<td>616</td>
<td>15 Craig Road, Acton, MA 01720</td>
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<td>Siemens Medical Solutions USA, Inc.</td>
<td>323</td>
<td>51 Valley Stream Parkway, Malvern, PA 19355</td>
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<td>SpineWave</td>
<td>302</td>
<td>Two Enterprise Drive, Suite 302, Shelton, CT 06484</td>
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<td>Springer</td>
<td>303</td>
<td>233 Spring Street, New York, NY 10013</td>
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<td>Stryker Interventional Spine</td>
<td>206</td>
<td>4100 East Milham Avenue, Kalamazoo, MI 49001</td>
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<td>Toshiba America Medical Systems, Inc.</td>
<td>407</td>
<td>2441 Michelle Drive, Tustin, CA 92780</td>
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<td>U.S. Radiology On-Call</td>
<td>104</td>
<td>2461 Santa Monica Boulevard #108, Santa Monica, CA 90404</td>
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<tr>
<td>Vertos Medical, Inc.</td>
<td>217</td>
<td>2362 Qume Drive, Suite D, San Jose, CA 95131</td>
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<td>Vital Images</td>
<td>516</td>
<td>5850 Opus Parkway, #300, Minnetonka, MN 55343</td>
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</tbody>
</table>
46th Annual Meeting Invited Speakers (As of 04/17/08)

Michael J. Alexander, MD, FACS
Duke University Medical Center

David Alsop, PhD
Beth Israel Deaconess Medical Center

Ali S. Arbab, MD, PhD
Henry Ford Health Systems

Meenakshi B. Bhattacharjee, MD, FRCP
Texas Children’s Hospital

Bharat Biswal, MD
University of Medicine & Dentistry of New Jersey - NJMS Rivers Lab

Kristine Blackham, MD
University Hospitals of Cleveland / Case Medical Center

Susan I. Blaser, MD
Hospital for Sick Children

Michael Brant-Zawadzki, MD
Hoag Memorial Hospital

Allan L. Brook, MD
Memorial Sloan-Kettering Cancer Center

Montefiore Medical Center

Jeff W.M. Bulte, PhD
Johns Hopkins University Medical School, Kennedy Krieger Institute

Jonathan H. Burdette, MD
Wake Forest University School of Medicine

Timothy J. Carroll, MD
Northwestern University Medical School

BJ Casey, PhD
Sackler Institute, Weill Cornell Medical College

Cesare Colosimo, MD
Università Cattolica del Sacro Cuore, Rome, Italy

Scott H. Faro, MD
Temple University School of Medicine

Aaron S. Field, MD, PhD
University of Wisconsin

Nancy J. Fischbein, MD
Stanford University Medical Center

Evan K. Fram, MD
The Barrow Neurological Institute

J. James Frost, MD, PhD, MBA
Yale University School of Medicine

Lawrence E. Ginsberg, MD
Mount Sinai Hospital, Toronto, Canada

Meng Law, MD
Mount Sinai Medical Center, New York

Jonathan S. Lewin, MD
Johns Hopkins Outpatient Center

Eric Lis, MD
Memorial Sloan-Kettering Cancer Center, Weill Medical College

Laurie A. Loevner, MD
University of Pennsylvania Medical Center

Fredd A. Mann, MD
Seattle Radiologists, APC

Thomas J. Masaryk, MD
The Cleveland Clinic Foundation

Bruce McCandliess, PhD
Weill Medical College of Cornell University

Andreas Meyer-Lindenberg, MD, PhD, MSc
Central Institute of Mental Health, Mannheim, Germany

Philip M. Meyers, MD
Columbia University

David J. Mikulicis, MD
Toronto Western Hospital, Toronto, Canada

Pratik Mukherjee, MD, PhD
University of California, San Francisco

Perry P. Ng, MB, BS, DRANZCR
University of Utah

Jennifer Northrop, MD, PhD
Texas Children’s Hospital

Ashok Panigrahy, MD
Children’s Hospital, Los Angeles

Michael J. Pentecost, MD
Kaiser Permanente

C. Douglas Phillips, MD
University of Virginia Health Systems

Jay J. Pillai, MD
The Johns Hopkins Medical Institutions

Christopher M. Putman, MD
Inova Fairfax Hospital

Ansaar T. Rai, MD
West Virginia University

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

Caroline D. Robson, MB, ChB
Children’s Hospital, Harvard Medical School

Jeffrey S. Ross, MD
Barrow Neurological Institute, St. Joseph’s Hospital

Andrea Rossi, MD
G. Gaslini Children’s Hospital, Genova, Italy

David Saloner, MD
University of California, San Francisco

Ami Samdani, MD
Shriners Hospital for Children, Philadelphia

Pina C. Sanelli, MD
New York Presbyterian Hospital

Fernando Scaglia, MD
Texas Children’s Hospital Clinical Care Center

Eric D. Schwartz, MD
University of Pittsburgh, Medical Center

Erin Simon Schwartz, MD
The Children’s Hospital of Philadelphia

David J. Seidenwurm, MD
Radiological Associates of Sacramento Medical Group, Inc.

Wendy R.K. Smoker, MD, FACR
University of Iowa Hospitals & Clinics

Peter M. Som, MD, FACR
The Mount Sinai Medical Center

A. Gregory Sorensen, MD
Massachusetts General Hospital

Daniel C. Sullivan, MD
Duke University Medical Center

Keith R. Thulborn, MD, PhD
University of Illinois at Chicago

Apostolos J. Tsouris, MD
New York Presbyterian Hospital, Cornell Campus

Aquilla S. Turk, DO
Medical University of South Carolina

Michael Tyszka, PhD
California Institute of Technology

John L. Ulmer, MD
Fresenius Memorial Lutheran Hospital

Johan Van Goethem, MD, PhD
University Hospital of Antwerp, Germany

Gilbert Yezina, MD
Children’s National Medical Center

Robert C. Wallace, MD
Barrow Neurological Institute

Alyssa T. Watanabe, MD
University of Southern California

Van J. Wedeen, MD, PhD
Massachusetts General Hospital

Elysia Widjaja, MD
Hospital for Sick Children, Toronto, Canada

Angus Wilfong, MD
Texas Children’s Hospital

MAY 31 – JUNE 5, 2008

ASNR 46th ANNUAL MEETING

Proceedings Front Matter 08_F:cr 4/21/08 4:20 PM Page XXXVI
Scientific Program Overview  (As of 04/17/08)

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 46th ANNUAL MEETING

Monday, June 2

6:00am - 7:35am
BREAKFAST

6:30am - 7:30am
HOW-TO SESSION BREAKFAST
Sponsor: Philips Medical Systems

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

7:45am - 8:45am
(2) MAINTENANCE OF CERTIFICATION (MOC) - PEDIATRIC AND ADULT BRAIN REVIEW SESSION (AR+)
Page 1

8:45am - 10:15am
(3) GENERAL SESSION: ADVANCES IN NEUROSCIENCE USING NMR: GENES BRAIN AND BEHAVIOR
Page 2

10:15am - 10:40am
MORNING BREAK

10:45am - 12:30pm
(4) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Pediatric: Cerebrovascular, Congenital, Degenerative & Metabolic Diseases/Excerpta Page 4
(b) Adult Brain: Degenerative, Demyelinating, Metabolic Diseases Page 12
(c) Adult Brain: Functional I Page 20
(d) Head & Neck: Temporal Bone & Neck/Excerpta Page 28

10:45am - 12:15pm
(5) ELC Workshop A: Introduction to PowerPoint
Page 37

12:15pm - 1:25pm
LUNCH BREAK

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

1:30pm - 3:00pm
(8) GENERAL PROGRAMMING: USE OF IMAGING AS BIOMARKERS AND SURROGATES FOR ASSESSMENT OF NEW TREATMENTS
Page 42

1:30pm - 3:00pm
(9) ELC Workshop B: Adobe Photoshop and Elements
Page 43

1:30pm - 3:00pm
(10) ASNR BUSINESS CENTER PROGRAMMING - PART I
Page 44

3:00pm - 3:25pm
AFTERNOON BREAK

3:30pm - 5:00pm
(11) ASNR BUSINESS CENTER PROGRAMMING - PART II
Page 44

3:30pm - 5:00pm
(12) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Adult Brain: Cerebrovascular Occlusive Diseases Page 45
(b) Adult Brain: Neoplasms I Page 51
(c) Head & Neck: Orbital Faces and New Techniques Page 60
(d) Pediatric: Neoplasms & New Techniques/Excerpta Page 66

3:30pm - 5:00pm
(13) ELC Workshop A: Introduction to PowerPoint
Page 73

5:00pm - 6:30pm
(14) ASHNR PROGRAMMING SKULL BASE AND CRANIAL NERVES
Page 74

5:00pm - 6:30pm
(15) ASPNR programming NEUROCARDIOLOGY - THE HEART AND BRAIN CONNECTION
Page 75

5:00pm - 6:30pm
(16) ADVANCED IMAGING SEMINAR - DIFFUSION TENSOR IMAGING
Page 77

5:00pm - 6:30pm
(17) ELC Workshop C: Advanced PowerPoint
Page 78

AR+ = Audience Response Plus+ Session

1Note: Programming is currently under review for qualification as a Self Assessment Module (SAM) through the American Board of Radiology (ABR).
Scientific Program Overview  
(As of 04/17/08)

Tuesday, June 3

6:30am - 7:55am
BREAKFAST

6:30am - 7:30am
HOW-TO SESSION BREAKFAST
Sponsor: Bracco Diagnostics, Inc.

7:45am - 8:45am
(18) MAINTENANCE OF CERTIFICATION (MOC) - ENT AND ADULT SPINE REVIEW SESSION (AR+)
Page 79

8:45am - 10:15am
(19) GENERAL SESSION: MINOR HEAD TRAUMA
Page 79

10:15am - 10:40am
MORNING BREAK

10:45am - 12:30pm
(20) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Interventional: Aneurysms I Page 81
(b) Adult Brain: Trauma, Inflammation & Ischemic Disease/Excerpta Page 88
(c) Adult Brain: Functional II Page 96
(d) Pediatric: Functional Imaging Page 104

10:45am - 12:15pm
(21) ELC Workshop C: Advanced PowerPoint
Page 113

12:15pm - 1:25pm
LUNCH BREAK

12:30pm - 1:30pm
FELLOWS' LUNCHEON

12:30pm - 1:30pm
LUNCH HOW-TO SESSION
Sponsor: GE Healthcare

12:30pm - 1:30pm
American Society of Functional Neuroradiology (ASFNR) Annual Business Meeting (Members Only)

12:30pm - 1:30pm
American Society of Pediatric Neuroradiology (ASPNR) Annual Business Meeting (Members Only)

1:30pm - 3:00pm
(25) ASNR BUSINESS CENTER PROGRAMMING - PART I
Page 117

1:30pm - 3:00pm
(26) GENERAL SESSION: HOW I DO IT...
PERFUSION IMAGING AND THE POST-OPERATIVE BACK
Page 118

3:00pm - 3:25pm
AFTERNOON BREAK

3:30pm - 5:00pm
(28) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Adult Brain: Functional Imaging/fMRI Page 119
(b) Pediatric: Epilepsy, Inflammatory, Infectious Diseases/Excerpta Page 125
(c) Head & Neck: Pharynx, Larynx, Soft Tissue, Sinonasal & Other Page 133
(d) Spine: Spine Interventions, Vascular Lesions and Vertebroplasty I Page 139

3:30pm - 4:30p
(29) ELC Lecture B: PACS and RIS 2008: An Update
Page 145

5:00pm - 6:30pm
(30) (ASPNR) INTERESTING PEDIATRIC CASES (AR+)
Page 146

5:00pm - 6:30pm
(31) ASHNR PROGRAMMING PITFALLS AND CHALLENGES IN HEAD AND NECK IMAGING
Page 146

5:00pm - 6:30pm
(32) ADVANCED IMAGING SEMINAR - fMRI AND MEG
Page 147

5:00pm - 6:00pm
(33) ELC Lecture A: Speech Recognition
Page 148

6:30pm - 9:30pm
ASNR Reception with Technical Exhibitors
Hall A - 6:30pm - 8:00pm
La Louisiane Ballroom - 8:00pm - 9:30pm

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1Note: Programming is currently under review for qualification as a Self Assessment Module (SAM) through the American Board of Radiology (ABR).
Scientific Program Overview (As of 04/17/08)

Wednesday, June 4

6:30am - 7:55am
BREAKFAST

7:40am - 8:40am
(34) MAINTENANCE OF CERTIFICATION (MOC) - ADULT BRAIN AND PEDIATRIC SPINE REVIEW SESSION (AR+)
Page 149

8:40am - 8:50am
Memorial: J. Arliss Pollock, MD - Visionary, Leader and Humanitarian
Moderator: David J. Seidenwurm, MD
Page 149

8:50am - 10:20am
(35) GENERAL SESSION: SOCIOECONOMIC ISSUES SELF ASSESSMENT MODULE (SAM)1 SESSION (AR+)
(2008 J. ARLISS POLLOCK, MD MEMORIAL LECTURE)
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10:20am - 10:40am
MORNING BREAK

10:40am - 10:55am
(36) ASNR PRESIDENTIAL ADDRESS
Page 151

10:55am - 11:05am
(37) ASNR Award Announcements
-Gold Medal Award
-NER Foundation Outstanding Contributions in Research Award
-2007 Outstanding Presentation Awards
-NER Foundation Scholar Award in Neuroradiology Research
-NER Foundation/Boston Scientific Fellowship in Cerebrovascular Disease Research
-Bayer/NER Foundation Fellowship in Basic Science Research Award
Page 151

11:05am - 11:50am
(38) KEYNOTE LECTURE: Future Directions - Moving Toward Solutions to Image Overload Through An Understanding of Visual Perception and Cognition
Page 152

11:50am - 12:15pm
(39) American Society of Neuroradiology (ASNR) Annual Business Meeting (Members Only)
Page 152

11:50am - 1:15pm
LUNCH BREAK

12:15pm - 1:15pm
LUNCH HOW-TO SESSION
Sponsor: GE Healthcare

1:15pm - 2:45pm
(41) SNIS PROGRAMMING - ANEURYSM Page 155

1:15pm - 2:45pm
(42) (ASFNR) MOLECULAR IMAGING - FROM THE BENCH TO CLINICAL PRACTICE SELF ASSESSMENT MODULE (SAM)1 (AR+)
Page 156

1:15pm - 2:45pm
(43) GENERAL SESSION: HOW I DO IT... POST-OPERATIVE NECK AND MS
Page 157

1:15pm - 2:45pm
(44) ELC Workshop C: Advanced PowerPoint
Page 188

2:45pm - 3:10pm
AFTERNOON BREAK

3:15pm - 4:45pm
(45) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Socioeconomics & Anatomy Page 158
(b) Adult Brain: Vascular, Intracranial Page 164
(c) Spine: Degenerative, Inflammatory, Infectious, Demyelinating Diseases/Excerpta Page 171
(d) Interventional: New Techniques and Devices Page 178

3:30pm - 4:30pm
(46) ELC Lecture B: MRI Safety
Page 184

4:45pm - 6:15pm
(47) (ASFNR) STATE OF THE ART BRAIN TUMOR PRE-SURGICAL MAPPING II: BEYOND BOLD PLUS PRACTICAL CONSIDERATIONS
Page 185

4:45pm - 6:15pm
(48) SNIS PROGRAMMING - AVMs SELF-ASSESSMENT MODULE (SAM)1 SESSION (AR+)
Page 188

4:45pm - 6:15pm
(49) ASSR PROGRAMMING - SCOLIOSIS
Page 190

4:45pm - 6:15pm
(50) ADVANCED IMAGING SEMINAR - PERFUSION AND VASCULAR HEMODYNAMICS
Page 190

5:00pm - 6:30pm
(51) ELC Workshop E: Advanced Web Design
Page 192

AR+ = Audience Response Plus+ Session

1Note: Programming is currently under review for qualification as a Self Assessment Module (SAM) through the American Board of Radiology (ABR).
Scientific Program Overview  (As of 04/17/08)

Thursday, June 5

6:30am - 7:55am
BREAKFAST

7:45am - 8:45am
(52) MAINTENANCE OF CERTIFICATION (MOC) - INTERVENTIONAL AND ENT REVIEW SESSION (AR+)
Page 193

8:45am - 10:00am
(53) GENERAL SESSION: INTRAOPERATIVE IMAGING
Page 193

10:00am - 10:25am
MORNING BREAK

10:30am - 12:15pm
(54) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Spine: Spinal Cord, Neoplasms & Other/Excerpta Page 195
(b) Interventional: Aneurysms II Page 205
(c) Adult Brain: Miscellaneous Page 212
(d) Adult Brain: New Techniques & Post Processing Page 221

12:15pm - 1:25pm
LUNCH BREAK

1:30pm - 3:00pm
(55) SNIS PROGRAMMING - STROKE
Page 231

1:30pm - 3:00pm
(57) GENERAL SESSION: HOW I DO IT... THYROID LESIONS AND VENOUS THROMBOSIS
Page 233

1:30pm - 3:00pm
(58) ADVANCED IMAGING SEMINAR - MOLECULAR IMAGING AND SPECTROSCOPY
Page 234

3:00pm - 3:25pm
AFTERNOON BREAK

3:30pm - 5:00pm
(59) PARALLEL SCIENTIFIC PAPER SESSIONS
(a) Adult Brain: Neoplasms II Page 235
(b) Adult Brain: Vascular, Extracranial Page 242
(c) Interventional: Arteriovenous Malformations, Fistulae, Thrombolysis & Stroke Page 249
(d) Spine: Spinal Cord Injections & Vertebroplasty II Page 255

5:00pm - 5:15pm
(60) CLOSING REMARKS
Page 260

AR+ = Audience Response Plus+ Session

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

7:40 AM – 7:45 AM
La Louisiane Ballroom

(1) Opening Remarks

— David M. Yousem, MD, MBA, ASNR President

Monday Morning

7:45 AM – 8:45 AM
La Louisiane Ballroom

(2) Maintenance of Certification (MOC) – Pediatric and Adult Brain Review Session
Audience Response Plus+ (AR+)*

(2) Pediatric Brain

— Gilbert Vezina, MD

(3) Adult Brain - Cerebrovascular Disease

— Apostolos J. Tsiouris, MD

Moderator: Apostolos J. Tsiouris, 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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**Pediatric Brain**

*Gilbert Vezina, MD*

**LEARNING OBJECTIVES**

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

1) Recognize a range of pediatric brain pathologies.
2) Analyze pediatric brain MRI cases, similar in level of difficulty to that seen on Maintenance of Certification (MOC) exams.
3) Develop an appropriate differential diagnosis.

**PRESENTATION SUMMARY**

Unknown cases with pertinent multiple choice questions will be presented. Illustrative cases of congenital and acquired disorders of the pediatric brain will be used; the difficulty level will be that expected within the fund of knowledge possessed by neuroradiologists.

**Adult Brain - Cerebrovascular Disease**

*Apostolos J. Tsiouris, MD*
Monday Morning
7:45 AM – 8:45 AM
La Louisiane Ballroom

(3) General Session: Advances in Neuroscience Using NMR, Genes, Brain and Behavior

(4) Developmental and Individual Differences: New Insight into Heighted Emotional Reactivity in Teens
   — BJ Casey, PhD

(5) Anatomic Correlates of Genetic Variation: Potential Biomarkers for Psychiatric Disorders
   — Andreas Meyer-Lindenberg, MD, PhD, MSc

(6) Imaging Genetics and the Search for Predictive Biologic Markers of Neuropsychiatric Disease Risk
   — Ahmad R. Hariri, PhD

Moderator: BJ Casey, PhD

Presentation Summary
Adolescence is a transition period from childhood to adulthood that often is characterized by emotional instability. This period is also a time of increased incidence of anxiety and depression underscoring the importance of understanding biological substrates of behavioral and emotion regulation during adolescence. Developmental changes in the brain in concert with individual predispositions for anxiety may underlie the increased risk for poor outcomes reported during adolescence. We examined the association between emotion regulation, and frontoamygdala circuitry in 60 children, adolescents, and adults. Adolescents showed exaggerated amygdala activity relative to children and adults. This age-related difference decreased with repeated exposures to the stimuli, and individual differences in self-ratings of anxiety predicted the extent of adaptation or habituation in amygdala. Individuals with higher trait anxiety showed less habituation over repeated exposures. This failure to habituate was associated with less functional connectivity between ventral prefrontal cortex and amygdala. These findings suggest that exaggerated emotional reactivity during adolescence may increase the need for top-down control and put individuals with less control at greater risk for poor outcomes. The findings will be discussed in terms of genetic risk factors.

Anatomical Correlates of Genetic Variation: Potential Biomarkers for Psychiatric Disorders
Andreas Meyer-Lindenberg, MD, PhD, MSc

Dr. Meyer-Lindenberg studied medicine at Bonn (Germany) and Cornell University and did residencies in psychiatry and psychotherapy in Giessen (Germany) and in neurology in Bonn. He received his M.D. in 1991 and his Ph.D. (Habilitation) in 1999. He is board certified in psychiatry, psychotherapy and neurology. He also holds a Master's degree in pure and applied mathematics from the University of Hagen (Germany). Dr. Meyer-Lindenberg worked at NIMH from 1997-2007, first as a Visiting Associate, then as a Staff Clinician in the Section on Integrative Neuroimaging, and was the co-director of the GCAP Neuroimaging Core Facility since 2004 and chief of the Unit for Systems Neuroscience in Psychiatry from 2005. From July 2007, he is Director of the Central Institute of Mental Health, Mannheim, Germany, Medical Director of the Department of Psychiatry and Psychotherapy at the Institute, and Chair of Psychiatry and Psychotherapy at the University of Heidelberg. His research interests are focused on using multimodal neuroimaging approaches to characterize functional brain circuits underlying genetic risk for psychiatric disorders and cognitive dysfunction.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Identify three common methods to investigate anatomical correlates of genetic variation.
2) Discuss evidence for heritability of anatomical variation in various regions of the brain.
3) Identify opportunities and pitfalls of using anatomical imaging genetics methods as biomarkers.

Developmental and Individual Differences: New Insight into Heighted Emotional Reactivity in Teens
BJ Casey, PhD

Dr. Casey is the Sackler Professor and Director of the Sackler Institute at Weill Cornell Medical College in Manhattan. She is a pioneer in novel uses of neuroimaging methodologies to examine human behavioral and brain development and how it goes awry in neurodevelopmental disorders. Her work takes a developmental psychobiological perspective in understanding the role of gene-environment interactions on behavior with a focus on typical and atypical developmental trajectories of behavioral and brain-based change. She is on the NIMH Board of Scientific Counselors and NARSAD Scientific Council.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Illustrate how imaging has advanced knowledge of risk factors for psychiatric illness in adolescence.
2) Illustrate the utility of fMRI in understanding adolescent brain development and function.
Many severe psychiatric disorders are highly heritable, and genetic variants contributing to that risk are increasingly being identified. Since it is clear that the pathophysiology of genetic risk in psychiatry must involve the brain at some point, translational neuroimaging approaches are useful to identify contributing mechanisms. In this talk, we will focus on anatomical neuroimaging data related to heritability and genetic risk, discussing methods to delineate regional volume changes, cortical thickness, and structural connectivity as well as on data from diffusion tensor imaging. Results from neurogenetic syndromes, schizophrenia, and risk variants for depression and anxiety will be discussed, and their applicability as biomarkers.

**Imaging Genetics and the Search for Predictive Biologic Markers of Neuropsychiatric Disease Risk**

Ahmad R. Hariri, PhD

After completing his BS (1994) and MS (1997) in evolutionary biology at the University of Maryland, Dr. Hariri completed his doctoral work (2000) in the UCLA Interdepartmental PhD Program for Neuroscience. While a doctoral student working in the laboratory of Susan Y. Bookheimer, PhD, Dr. Hariri began research utilizing functional magnetic resonance imaging (fMRI) to identify the contributions of the amygdala and prefrontal cortex to the emergence of individual differences in emotional reactivity. Dr. Hariri continued his research on the neurobiology of individual differences as a postdoctoral fellow in the NIMH laboratory of Daniel R. Weinberger, MD. It was during his time in Dr. Weinberger's lab that Dr. Hariri developed an interest in combining neuroimaging technologies and molecular genetics to more fully characterize the biological pathways mediating individual differences in complex behaviors, as well as related risk for neuropsychiatric diseases. In 2003, Dr. Hariri joined the faculty of the Department of Psychiatry at the University of Pittsburgh where he continues his research exploring the nature of individual differences.

**Learning Objectives**

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

1) Illustrate usefulness of combining fMRI, PET and molecular genetics to reveal mechanisms of individual differences in behavior.

2) Illustrate potential of combining fMRI, PET and molecular genetics for establishing predictive markers of neuropsychiatric disease vulnerability.

**Presentation Summary**

Individual differences in trait affect, personality and temperament are important predictors of vulnerability to neuropsychiatric disorders including depression, anxiety and addiction. Accordingly, identifying the biological mechanisms which give rise to trait individual differences affords unique opportunity to develop both predictive markers of disease liability and identify novel targets for individualized treatment. In the past 5 years, human neuroimaging studies, especially those employing BOLD fMRI, have begun to reveal the neural substrates of inter-individual variability in these and related constructs. Moreover, recent studies have established that BOLD fMRI measures represent temporally stable and reliable indices of brain function. Thus, much like their behavioral counterparts patterns of brain activation represent enduring, trait-like phenomenon, which in and of themselves may serve as important markers of liability and pathophysiology. As neuroimaging studies continue to illustrate the predictive relationship between regional brain activation and trait-like behaviors (e.g., increased amygdala reactivity predicts core features of anxious temperament), an important next step is to systematically identify the underlying mechanisms driving variability in brain circuit function.

In this regard, recent neuroimaging studies employing pharmacological challenge paradigms, principally targeting monoamine neurotransmission, have revealed that even subtle alterations in dopaminergic, noradrenergic and serotonergic signaling can have profound impact on the functional response of brain circuitries supporting affect, personality and temperament. Similarly, multimodal neuroimaging approaches have provided evidence for directionally specific relationships between key components of monoaminergic signaling cascades, assessed with radiotracer PET, and brain function, assessed with BOLD fMRI. Collectively, pharmacological challenge neuroimaging and multimodal PET/fMRI are revealing how variability in behaviorally-relevant brain activation emerges as a function of underlying variability in key brain neurotransmission systems (e.g., increased serotonin signaling predicting increased amygdala reactivity). The next logical step is to identify the sources of inter-individual variability in these key neurochemical signaling mechanisms. In the modern era of human molecular genetics, this step is firmly planted in the direction of identifying the relationships between common variation in the genes encoding components of these signaling cascades, their protein products and, subsequently, brain circuit function. As sequence variation across individuals represents the ultimate wellspring of variability in emergent neurobiological and related behavioral processes, understanding the relationships between genes, brain and behavior is critical for establishing the etiology and pathophysiology of psychiatric disease. The emerging field of imaging genetics seeks to establish a principled framework for the integration of modern molecular genetics and neuroimaging technologies towards the ultimate goal of identifying truly predictive markers of disease vulnerability. The vast potential of such an integrated approach will be highlighted through recent studies whose collective results demonstrate that common sequence variation in the human serotonin transporter gene is associated with downstream alterations in serotonin signaling cascades that result in relatively increased serotonin signaling and, eventually, increased amygdala reactivity to environmental threat. This genetically driven variability in serotonin neurotransmission and threat-related amygdala reactivity likely represents a key mechanism of increased temperamental anxiety and risk for depression, especially in the context of environmental adversity. With increased utilization of such imaging genetics strategies and their continued expansion to include pharmacological and multimodal neuroimaging techniques, many more behaviorally- and clinically-relevant neurobiological pathways and predictive markers will be illuminated in forthcoming years.
Dynamic Gadolinium Time-Resolved MR Angiography in Pediatric Cerebrovascular Disease

**Purpose**
To evaluate the utility of dynamic time-resolved gadolinium-enhanced 3D MRA utilizing a new sequence (TWIST) in pediatric patients with cerebrovascular disease.

**Materials & Methods**
Thirty-five children with suspected or known cerebrovascular disease, age 4 to 18 years, received not only conventional 3D time-of-flight MRA, but a postgadolinium bolus time-resolved MRA study for comparison.

**Results**
Dynamic MRA showed positive results in one third of the patients studied, demonstrating delay or absence of flow in patients with distal internal carotid artery stenosis or occlusion. Reversal of flow also was seen in steal situations as well as alterations in blood flow dynamics accompanying vascular malformations.

**Conclusion**
Dynamic gadolinium-enhanced MRA adds a second dimension to routine MRA, that of flow alteration over time, that adds to our understanding of pediatric cerebrovascular disease.

**Key Words:** Cerebrovascular disease, pediatrics, MRA
aneurysms in this series were saccular and follow up should probably be prolonged in these patients.

**KEY WORDS:** Aneurysm, pediatric

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

**Neuroimaging Features in Loeys Dietz Syndrome**

Danehy, A. R. · Lacro, R. · Orbach, D. · Robertson, R.
Childrens Hospital
Boston, MA

**PURPOSE**

Loeys Dietz syndrome is a recently described inherited disorder that manifests as early ascending aortic aneurysm with widespread systemic arterial involvement. The aim of this study is to describe the neuroimaging features in a series of patients with Loeys Dietz syndrome.

**MATERIALS & METHODS**

The medical records and neuroimaging studies were reviewed in 10 patients with genetically confirmed or suspected Loeys Dietz syndrome.

**RESULTS**

Diffuse tortuous and ectatic intra and extracranial carotid and vertebral arteries, of varying degrees, were observed in all 10 patients. Other neuroimaging findings included two patients with craniosynostosis, one Chiari I malformation, and one patient with nonspecific T2 white matter signal abnormalities.

**CONCLUSION**

Loeys Dietz syndrome has unique neuroimaging features most commonly manifesting as tortuous arteries in the head and neck.

**KEY WORDS:** Loeys Dietz syndrome, cerebrovascular disease

**Paper 10 Starting at 11:09 AM, Ending at 11:14 AM**

**Ophthalmoplegic Migraine: Case Report and Imaging Findings**

Bruno, C. A. · Stollman, N. B. · McGinley, M. · Koenigsberg, R. A.
Drexel University College of Medicine
Philadelphia, PA

**PURPOSE**

Ophthalmoplegic migraine (OM) is a rare disorder characterized by paresis of the oculomotor nerve, trochlear nerve or abducens nerve in association with migrainous headache. It occurs most frequently in infancy or young adulthood and its pathophysiology remains unknown. Several mechanisms have been proposed, including ischemic neuropathy, inflammation, and demyelination.

**CASE REPORT**

We present a case of ophthalmoplegic migraine and describe the magnetic resonance imaging (MRI) findings. Implications from these findings are discussed in relation to the pathophysiology of OM. We present a 16-year-old female, who presented to our institution with acute onset diplopia and headache. Examination demonstrated complete right third nerve palsy with pupillary involvement. The patient admitted to 12 similar episodes, the first at 7 months of age. Her symptoms typically resolved in several months. MRI and MR angiography (MRA) were subsequently performed. The patient was treated with high dose prednisone and discharged 7 days later.

**IMAGING FINDINGS**

Postcontrast T1-weighted MRI of the head showed globoid thickening and homogeneous enhancement of the cisternal segment of the oculomotor nerve (Figure). MR angiography of the head and neck was normal. Postcontrast MRI 6 months following resolution of symptoms showed less intense enhancement and less swelling.

**SUMMARY**

Thickening and enhancement of the cisternal segment of the oculomotor nerve during the acute phase of OM is well recognized. MR imaging findings suggest an inflammatory or demyelinating etiology rather than an ischemic one. The typical globoid appearance of the proximal portion of the oculomotor nerve as it exits the midbrain suggests a localized area of intraneural edema as seen in demyelinating neuropathies. The temporal relationship with clinical symptoms and resolution with steroids further supports an inflammatory theory. The findings are not pathognomonic; on initial presentation, other etiologies must be considered. Enhancement of the cisternal portion of the oculomotor nerve can occur with schwannomas, lymphoma, syphilis, HIV, sarcoidosis, and Tolosa-Hunt syndrome.

**REFERENCES**


**KEY WORDS:** Ophthalmoplegic migraine, MRI, oculomotor palsy
Spontaneous Thrombosis of Large Vein of Galen Aneurysm without Treatment

McKinney, A. M. · Gadani, S.
University of Minnesota & Hennepin County Medical Centers
Minneapolis, MN

PURPOSE
Spontaneous healing/thrombosis of aneurysms of the vein of Galen (AVG) is rare. Overall, about 26 cases have been described previously; however, the majority have undergone ventriculoperitoneal shunting, followed catheter angiography (possibly from feeding artery thrombosis), or have suffered meningitis (potentially scarring the feeding artery or draining vein). We describe the utility of subtracted pre/post-contrast MRA MRV in a case of spontaneously thrombosed AVG followed via 3.0 T MRA MRV.

CASE REPORT
A 2-month-old male presented with severe hydrocephalus, and a 4cm mass centered over the pineal region. Patient underwent emergent ventriculoperitoneal shunting, with tip in the anterior interhemispheric fissure (outside of the ventricles), and moderate improvement in the hydrocephalus. At that time, pre and postcontrast MRA MRV demonstrated the large, patent malformation. Subsequent MRA MRV examination at 6 months age also demonstrated patency. The patient then was referred for endovascular treatment of the AVG at 9 months age. In planning for catheter angiography, patient again underwent pre and postcontrast time-of-flight (TOF) MRA MRV and 3D T1-weighted gradient-echo postcontrast images, all demonstrating a component of T1-bright clot and suspected thrombosis. However, precontrast images demonstrated that the clot was centrally isointense while peripherally hyperintense on T1, raising the question of residual flow. Subtraction of pre from the postcontrast TOF MRA MRV confirmed the lack of flow. Due to clear demonstration of complete AVG thrombosis, catheter angiography was avoided. A repeat MRI at 11 months age demonstrated that the AVG remained entirely thrombosed.

IMAGING FINDINGS
Figure 1 demonstrates that at 9 months age, the previously entirely patent AVG has subacute clot peripherally, while centrally there is isointensity raising the question of some patency of the AVG (left). However, the postcontrast MRA MRV combination (middle) shows entirely T1 brightness throughout the AVG. Subtraction of pre from postcontrast TOF images demonstrates a lack of patency of the AVG (right).

SUMMARY
Aneurysms of the vein of Galen rarely undergo spontaneous thrombosis; typically this occurs following catheter angiography, shunting, or meningitis. Our case demonstrates spontaneous thrombosis without catheter angiography or meningitis, with a far anterior shunt placed outside of the ventricles. Imaging in this case demonstrates that AVGs can be followed by serial TOF MRA MRV pre and postcontrast, where subtraction can confirm complete occlusion of such malformations, helpful in the scenario of subacute thrombus.
CONCLUSION
Hypoplasia of the straight sinus supports the embryologic explanation for persistent falcal sine. Persistent falcal sine should prompt attention to the brain and exclude anomalies like atretic cephaloceles, Chiari malformation. To the best of our knowledge duplicated falcal has not been reported previously.

KEY WORDS: Falcal sine

Paper 13 Starting at 11:27 AM, Ending at 11:35 AM
Brain MR Imaging in the Diagnosis of Mitochondrial Respiratory Chain Disorders in Children

Cordeiro, M. N. C. • Diogo, L. • Garcia, P. • Lopes da Silva, S. • Grazina, M. • Garcia, T.

1Hospital da Universidade de Coimbra, Coimbra, PORTUGAL, 2Hospital Pediatico de Coimbra, Coimbra, PORTUGAL, 3Coimbra Medical School, Coimbra, PORTUGAL, 4Centro Hospitalar de Coimbra, Coimbra, PORTUGAL

PURPOSE
Evaluate brain MR imaging (MRI) findings in a group of children investigated for mitochondrial respiratory chain disorders (MRCD) and try to identify distinctive brain image aspects of a MRC defect.

MATERIALS & METHODS
We reviewed the brain MR images of 133 pediatric patients (newborn to 15 years) investigated for MRCD at our hospital during 10 years. Patients, predominantly with nonspecific encephalopathy or encephalomyopathy (75%), were classified retrospectively according to Bernier’s criteria into four groups: definite (63 cases), probable (53), possible (7) and unlikely MRCD (10). Every patient had a brain MRI done in a 1.5 T scanner. Axial and sagittal planes were obtained in T1-, T2- and proton density-weighted images. Other sequences were obtained in some children, namely FLAIR, MR spectroscopy and diffusion-weighted images (DWI). The brain images were reviewed independently by two of the authors. Neuroimaging findings (brain atrophy, gray and white matter lesions and delayed myelination) of the 63 children in the definite group were compared with the remainder (70 patients) and with those in the possible or unlike MRCD group (17 cases). Neuroimaging findings were compared among the groups with Pearson-chi-square or Fisher tests.

RESULTS
Abnormalities in brain MRI were found in 74% of the patients corresponding to 70%, 77% and 65% in the definite, probable and possible/unlikely groups, respectively. MR imaging findings are summarized in the table. Lesions suggestive of Leigh syndrome were observed in six cases (9.5%) of the definite group and two of the probable (3.8%). No significant correlation between any of the studied MRI lesions, either analyzed in groups or individually and the definite MRCD group could be established.

Table 2 - MRI findings in 133 children with MRCD (in percentage of total)

<table>
<thead>
<tr>
<th>Imaging Findings</th>
<th>Definite N=63 (%)</th>
<th>Probable MRCD N=53 (%)</th>
<th>Possible/Unlikely N=17 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain atrophy</td>
<td>61.9</td>
<td>64.2</td>
<td>52.9</td>
</tr>
<tr>
<td>Cerebral cortical</td>
<td>54.0</td>
<td>73.5</td>
<td>35.3</td>
</tr>
<tr>
<td>Cerebral subcortical</td>
<td>27.0</td>
<td>44.1</td>
<td>11.8</td>
</tr>
<tr>
<td>Corpus callosum</td>
<td>17.5</td>
<td>47.1</td>
<td>5.9</td>
</tr>
<tr>
<td>Brainstem</td>
<td>1.6</td>
<td>8.8</td>
<td>11.8</td>
</tr>
<tr>
<td>Cerebellar</td>
<td>15.9</td>
<td>8.8</td>
<td>11.8</td>
</tr>
<tr>
<td>Diffuse</td>
<td>3.2</td>
<td>14.7</td>
<td>5.9</td>
</tr>
<tr>
<td>Supratentorial white matter lesions</td>
<td>20.6</td>
<td>15.1</td>
<td>29.4</td>
</tr>
<tr>
<td>Infratentorial white matter lesions</td>
<td>1.6</td>
<td>3.8</td>
<td>0.0</td>
</tr>
<tr>
<td>Delayed myelination</td>
<td>14.3</td>
<td>11.3</td>
<td>11.8</td>
</tr>
<tr>
<td>Basal ganglia</td>
<td>12.7</td>
<td>13.2</td>
<td>11.8</td>
</tr>
<tr>
<td>Thalamus</td>
<td>4.8</td>
<td>7.5</td>
<td>5.9</td>
</tr>
<tr>
<td>Sthalamic nuclei</td>
<td>1.6</td>
<td>3.8</td>
<td>0.0</td>
</tr>
<tr>
<td>Brainstem</td>
<td>6.3</td>
<td>9.4</td>
<td>5.9</td>
</tr>
<tr>
<td>Medulla oblongata</td>
<td>6.3</td>
<td>5.7</td>
<td>6.3</td>
</tr>
<tr>
<td>Pons</td>
<td>4.8</td>
<td>7.5</td>
<td>6.3</td>
</tr>
<tr>
<td>Peduncles</td>
<td>4.8</td>
<td>7.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Subth. nigra</td>
<td>3</td>
<td>5.7</td>
<td>0</td>
</tr>
<tr>
<td>Periaqueductal gray</td>
<td>4.8</td>
<td>9.4</td>
<td>0</td>
</tr>
</tbody>
</table>

CONCLUSION
In this series of 133 children investigated for MRCD, we have found no distinctive brain image features in the MRCD definite group, as compared with all the other patients in the sample and with the possible or unlikely MRCD group. One reason might be that many other causes of encephalic lesion ultimately are associated with MRC dysfunction and there is a common final pathogenic pathway for an array of diseases. Our results are contradictory with those of Dinapolos who demonstrated that deep gray matter lesions were significantly more frequent in children with definite MRCD, classified with Bernier criteria than in the probable and possible MRCD groups . Moreover, Barragan correlated widespread white matter hyperintensity and supratentorial cortical atrophy with mitocondrial cytopathies in adult patients with classical mitochondrial syndromes. Although unspecific for MRCD, brain MRI remains an important tool to assess the presence and degree of central nervous system involvement.

KEY WORDS: Mitochondrial respiratory chain disease, children, diagnostic criteria

Paper 14 Starting at 11:35 AM, Ending at 11:43 AM
Predictive Value of Brain MR Findings in Children with Mitochondrial Respiratory Chain Disorders

Cordeiro, M. N. C. • Diogo, L.

1Hospital da Universidade de Coimbra, Coimbra, PORTUGAL, 2Hospital Pediatico de Coimbra, Coimbra, PORTUGAL

PURPOSE
Correlate brain MR imaging (MRI) findings in a group of children investigated for mitochondrial respiratory chain disorders (MRCD) and their symptoms, signs and clinical evolution in order to try to suggest some imaging signs with possible prognostic value.
Materials & Methods
We reviewed the clinical records and brain MR images of 162 pediatric patients (newborn to 15 years) investigated for MRCD at our hospital during 10 years. Some characteristics studied are summarized in Table 1. We then correlated the clinical with the imaging findings (Table 2) in crosstables accessing its significance with Fisher exact test and its strength with Phi.

Results
Abnormalities in brain MRI were found in 74% of the patients. These findings are summarized in Table 2. Table 3 shows the statistically significant correlations found between the clinical and imaging elements studied.

Selected clinical findings in the population studied

<table>
<thead>
<tr>
<th>Clinical Finding</th>
<th>N=162</th>
<th>Clinical Finding</th>
<th>N=162</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intellectual delay</td>
<td>106</td>
<td>Evolution of Psychomotor development</td>
<td>55</td>
</tr>
<tr>
<td>Intraventricular Development delay</td>
<td>22</td>
<td>Evolution for autism</td>
<td>15</td>
</tr>
<tr>
<td>Myopathy at presentation</td>
<td>27</td>
<td>Evolution for change in behavior</td>
<td>21</td>
</tr>
<tr>
<td>Hypotonia at presentation</td>
<td>52</td>
<td>Evolution for ataxia</td>
<td>19</td>
</tr>
<tr>
<td>Apnea at presentation</td>
<td>7</td>
<td>Evolution for coma</td>
<td>21</td>
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<tr>
<td>Convulsions at presentation</td>
<td>31</td>
<td>Evolution for dyskinesia</td>
<td>11</td>
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<tr>
<td>Coma at presentation</td>
<td>8</td>
<td>Evolution for strabismus</td>
<td>19</td>
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<tr>
<td>Lacunar lesions at presentation</td>
<td>4</td>
<td>Evolution for optometrician</td>
<td>11</td>
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<tr>
<td>Myocardopathy at presentation</td>
<td>1</td>
<td>Evolution for eye disease</td>
<td>13</td>
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<tr>
<td>Heart arrhythmia at presentation</td>
<td>2</td>
<td>Evolution for myopathy</td>
<td>12</td>
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<tr>
<td>Evolution for muscular weakness</td>
<td>34</td>
<td>Evolution for apraxia</td>
<td>5</td>
</tr>
<tr>
<td>Evolution for muscular symptoms/ signs</td>
<td>18</td>
<td>Evolution for deficit</td>
<td>15</td>
</tr>
<tr>
<td>Evolution for neurologic symptoms/ signs</td>
<td>135</td>
<td>Evolution for cardiological symptoms</td>
<td>21</td>
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<td>Evolution for pyramidal symptoms</td>
<td>44</td>
<td>Evolution for respiratory symptoms</td>
<td>27</td>
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<td>Evolution for hypertension</td>
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Table 2 - MRI findings

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<thead>
<tr>
<th>MRI results N=162</th>
<th>MRI results N=162</th>
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<tbody>
<tr>
<td>Brain anomalies</td>
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<tr>
<td>Cortical anomalies</td>
<td>73</td>
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<tr>
<td>Subcortical anomalies</td>
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<td>Generalized anomalies</td>
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<tr>
<td>Cerebellar anomalies</td>
<td>19</td>
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<tr>
<td>Corpus callosum anomalies</td>
<td>32</td>
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<tr>
<td>Septooptical white matter lesions</td>
<td>35</td>
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<tr>
<td>Sinus lateral lesions</td>
<td>14</td>
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<td>Infraoptical white matter lesions</td>
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<td>Basal ganglia lesions</td>
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<td>Thalamic lesions</td>
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<td>Red nucleus lesions</td>
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<td>Substantia nigra lesions</td>
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<td>Subthalamic lesions</td>
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<td>Periventricular gray matter lesions</td>
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<td>Brain stem anomalies</td>
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<tr>
<td>Cerebellar lesions</td>
<td>8</td>
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<td>Pons lesions</td>
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<td>Medulla oblongata lesions</td>
<td>9</td>
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<td>Cerebellar nuclei lesions</td>
<td>2</td>
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<tr>
<td>Delay of myelination</td>
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Table 3: Significant Clinical-Imaging relations found

<table>
<thead>
<tr>
<th>Clinical Finding N=162</th>
<th>Clinical Finding N=162</th>
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<tbody>
<tr>
<td>Neurologic symptoms</td>
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<tr>
<td>Pyramidal symptoms</td>
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<tr>
<td>Evolution for neupathy</td>
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<td>Evolution for myopathy</td>
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<td>Evolution for ataxia</td>
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<td>Evolution for apraxia</td>
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<td>Evolution for myopia</td>
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<td>Evolution for coma</td>
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<td>Evolution for dyskinesia</td>
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<td>Evolution for deficit</td>
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<tr>
<td>Evolution for eye disease</td>
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</table>

Conclusion
Most of the relations found easily could be foreseen by our knowledge of brain anatomy and physiology. The study confirmed these relations in children with MRCD. Other relations are less obvious like cerebellar lesions in children with cardiological symptoms. Some MRI patterns might predict the clinical evolution of patients with suspected MRCD.

Key Words: Mitochondrial respiratory chain disorders, MR spectroscopy, metabolic disorders

Paper 15 Starting at 11:43 AM, Ending at 11:51 AM
Midbrain-Hindbrain Involvement in Lissencephalies

Jissendi Tchofo, P.1,2 · Kara, S.1 · Barkovich, A. J.·
1University of California San Francisco, San Francisco, CA, 2Hôpital Salengro, Chu Lille, Lille, FRANCE, &Kirikkale University, Kirikkale, TURKEY

Purpose
The aim of our study was: 1) to determine the involvement of the midbrain and hindbrain (MHB) in the groups of classical (cLIS), variant (vLIS), and cobblestone (CBSC) lissencephalies according to general classification and 2) to determine whether a correlation exists between the cerebral malformation and the midbrain-hindbrain abnormalities as determined by magnetic resonance imaging (MRI).

Materials & Methods
MR imaging scans of 111 patients were reviewed retrospectively. Patients were aged 1 day to 32 years (mean 5 years 4 months; median 2 years) at the time of MRI. After reviewing the brain involvement on MRI, the cases were reclassified according to known mutation (LIS1, DCX, ARX, VLDLR, RELN, MEB, WWS) or presumed (p) gene mutation (pLIS1, pDCX, pRELN, pARX, pVLDLR) based on characteristic MRI features. Following this initial classification, morphologic abnormalities in the posterior fossa then were recorded with separate attention to the midbrain, the pons, the medulla, the cerebellar vermis and the cerebellar hemispheres. A score was used for statistical purpose, ranging from 0 (normal) to 3 (severe), for each MHB structure. To assess the differences between defined groups of patients based on MHB features and to evaluate the correlation between the extent of brain agryria/pachygyria and MHB involvement, non parametric statistical tests were used, respectively Kruskal-Wallis test for multiple group comparison and χ2 Mc Nemar test (p<0.05).

Results
There was a significant correlation between the extent of brain involvement and severity of MHB abnormalities (p=0.0029). There was a significant difference between subgroups of the three major groups, namely cLIS, vLIS and CBSC as well as discriminating MHB MRI features. In regard to the overall score, there was a severity gradient of MHB involvement: cLIS (= 0 or 1) < vLIS (= 7) << CBSC (= 11 or 12).

Conclusion
Our findings led us to propose a new classification of lissencephalies correlating brain malformation type, MHB abnormalities and corresponding genetic mutation. Moreover, these results could help to predict the gene mutation associated with observed brain MRI features and thus to orientate genetic and molecular investigations.

Key Words: Lissencephaly, hindbrain, cobblestone cortex
Diffusion-Weighted Imaging in Fetuses with Callosal Agenesis and Abnormal Sulcal Morphology

Winklhofer, S. · Berman, J. · Bartha, A. · Baumer, F. · Barkovich, A. · Henry, R. · Glenn, O.
University of California San Francisco
San Francisco, CA

**PURPOSE**
To measure ADC values in fetuses with agenesis of the corpus callosum and unilateral abnormal sulcal morphology.

**MATERIALS & METHODS**
We retrospectively identified all cases of callosal agenesis with unilateral abnormal cortical infoldings diagnosed by fetal MR at our institution during an 11-year period. All fetal MR scans were performed using single-shot fast spin-echo (SSFSE) T2-weighted imaging acquired in the axial, sagittal, and coronal planes; and single-shot spin-echo echo-planar diffusion-weighted imaging acquired in the axial plane using a b-value of 0 and 600 sec/mm² (TR 4500 msec, TE minimum, field of view 32, matrix 128 x 128, slice thickness 5mm, skip 2mm, band-width=167 kHz). After review of the anatomical SSFSE T2 images, areas of cortical malformation were identified on the b=0 images, and regions of interest (ROI) were placed in the developing white matter underlying the cortical malformation on the ADC maps. Comparison ROIs of similar size were placed in corresponding regions in the contralateral hemisphere on the same slice. ADC values were averaged over multiple DWI series for each patient, whenever possible.

**RESULTS**
There were four MR scans of three fetuses with ACC and abnormal sulcal morphology affecting only one hemisphere. Median gestational age was 27.5 weeks by last menstrual period (range 21.4-28.9 weeks). One case, initially scanned at 21.4 gestational weeks, underwent a second fetal MR scan 7 weeks later. Abnormal sulcal morphology was characterized by multiple abnormal cortical infoldings, primarily involving the medial frontal lobe in two cases and more diffuse in one case. Abnormal infoldings occurred on the right side in two cases, and on the left side in one case. There was abnormal T2 hypointensity in the parenchyma underlying the areas of abnormal cortical infoldings in all cases. In all cases, there was sulcation delay in the contralateral hemisphere without abnormal cortical infoldings. Apparent diffusion coefficient values were 13% lower in areas underlying the abnormal sulcal morphology as compared to contralateral regions (range 6% - 25%). The percent decrease in ADC values was highest in older fetuses.

**CONCLUSION**
Apparent diffusion coefficient values are lower in the developing white matter underlying abnormal cortical infoldings as compared to the contralateral hemisphere in fetuses with callosal agenesis. This differs from reported increased and/or normal ADC values found in areas of cortical malformations in children (1, 2). Our findings suggest that there are structural abnormalities in the white matter underlying developing cortical malformations that can be detected in utero. Future studies using diffusion tensor imaging may give further insight into the organization and development of white matter in these fetuses.

**REFERENCES**

**KEY WORDS:** DWI, callosal agenesis, fetal MRI

**Paper 17 Starting at 11:59 AM, Ending at 12:07 PM**

**Agenesis of the Corpus Callosum: An MR Analysis of Associated Abnormalities in the Fetus**

Tang, P. H. · Bartha, A. · Norton, M. E. · Barkovich, A. · Sherr, E. H. · Glenn, O. A.
KK Women’s and Children’s Hospital, Singapore, SINGAPORE; 2University of California San Francisco, San Francisco, CA, 3Kaiser Permanente, San Francisco, CA

**PURPOSE**
To analyze anomalies detected by magnetic resonance (MR) imaging in fetuses with agenesis of the corpus callosum (ACC).

**MATERIALS & METHODS**
All cases of ACC diagnosed on fetal MR during an 11-year period were reviewed by a pediatric neuroradiologist blinded to the ultrasound and clinical information. Comparisons were performed using 2-sided Fisher’s exact test. Autopsy and/or postnatal MR were available in 10 cases. Neurodevelopmental outcome was assessed by questionnaire and/or review of medical records (range 1 mo to 6 yr). Neonatal deaths or living children with seizures, severe motor and/or cognitive impairment were classified as poor outcome.

**RESULTS**
Twenty-nine cases of ACC were diagnosed on fetal MR. Mean gestational age was 26.9 weeks by LMP (range 19.7-36.4 weeks). Sulcation abnormalities were present in 23 cases, characterized by abnormal morphology (12) and/or delayed sulcation (20). The proportion of fetuses with delayed sulcation was higher in those fetuses younger than 30 weeks gestation (20/21) than in those that were 30 weeks or older (0/7) (P=0.000007). Seven cases had dysplastic shaped lateral ventricle. The proportion of patients with dysplastic ventricles was higher in those with abnormal sulcal morphology (7/12) compared to those with normal sulcal morphology (0/15) (P=0.0009). There was a trend towards a greater proportion of patients with periventricular nodular heterotopia in those with abnormal (6/12) vs. normal sulcal morphology (2/15) (P=0.09). Fifteen fetuses had infratentorial abnormalities, involving the cerebellum (13), vermis (11), and brainstem (10). Nine cases had parenchymal signal abnormality. Deep gray nuclei were abnormal in five patients (dysplastic in 3, and associated with parenchymal destruction in 2). The proportion of patients with parenchymal signal abnormalities was higher in those with abnormal deep gray nuclei (4/5) vs those with normal deep gray nuclei (5/23) (P=0.03). The proportion of patients with abnormal deep gray nuclei was higher in those with posterior fossa...
abnormalities (5/14) vs normal posterior fossa (0/13) (P=0.04). There was a trend towards a greater proportion of patients with posterior fossa abnormalities in those with abnormal sulcal morphology (9/12) compared to those with normal sulcal morphology (5/15) (P=0.054). Of the 16 live births, three died during the neonatal period, six have seizures and/or severe neurodevelopmental disabilities, and seven are normal or have only mild neurodevelopmental delays. Abnormal sulcal morphology and/or infratentorial abnormalities were present in all patients with poor outcome, and absent in those with good outcome.

CONCLUSION
Sulcation abnormalities are the most common finding in fetuses with ACC. Sulcation delay was observed in nearly all fetuses younger than 30 weeks, including those with good outcome; whereas abnormal sulcal morphology was only seen in fetuses with poor outcome. The high frequency of sulcal abnormalities may reflect a primary abnormality in white matter formation, since formation of sulci is postulated to relate to white matter development (1). Future studies using diffusion tensor imaging may give insight into the development of white matter in these fetuses.

REFERENCES

KEY WORDS: Callosal agenesis, fetal MRI

Paper 18 Starting at 12:07 PM, Ending at 12:15 PM
Fetal Brain Pathology in Cardiac Malformations

Prayer, D. · Maschke-Mlczoch, E. · Ulm, B. · Salzer-Muhar, U. · Kasprian, G. · Brugger, P. C.
University Children’s Hospital
Vienna, AUSTRIA

PURPOSE
To identify the type and incidence of fetal brain pathology in fetuses with cardiac malformations.

MATERIALS & METHODS
Fifty-seven pregnant women underwent one or two fetal MR examinations between 20 and 38 gestational weeks (GW). MR imaging was done on a 1.5 T superconducting system using ultrafast T2-weighted (w), T1-, diffusion-w, and echo-planar sequences in three orthogonal section planes. The type of cardiac malformation was defined by ultrasound. Genetic workup was available in 15 cases.

RESULTS
Brain pathology was found in 33 cases (59%). Eighteen fetuses presented with malformations, consisting of commissural anomalies (3), holoprosencephaly (1), pathologies of the posterior fossa (4), tuberous sclerosis (3), malformations of cortical development (3) (Figure) and combined malformations (4). In 12 fetuses symmetrical/asymmetrical widening of the internal/external cerebrospinal fluid spaces was seen, consisting of ventricular enlargement more than 11 mm trigonal width, and/or widened subarachnoid spaces, two showed germinolytic cysts, and one displayed hemorrhagic lesions. Cardiac malformations consisted of: Fallot’s tetralogy (9), transposition of great vessels (3) ventricle septum defect +/- associated cardiac malformations (9), rhabdomyoma (3), aortic stenosis at the isthmus (3), arteriovenous canal (3), cardiomegaly (uni or bilaterally) (3) other pathologies, such as aneurysm, cardiac teratoma, missing inferior vena cava, and double outlet right ventricle were seen one each, in the remaining cases the cardiac malformation could not be classified yet. Genetically, in three cases a Di George syndrome was found, in two a trisomy 13. The remaining 11 tested cases had normal chromosomes.

Figure. Brain of fetus in gestational week 33, axial sections a) T2-weighted, b) diffusion-weighted, showing hemispheric defect with pathologic cortical formation.

CONCLUSION
The association between congenital heart disease and cerebral impairment is well known (1). The prenatal origin of brain pathology in such cases was suspected. This is proved now by the results of this study. In addition, the wide range of anomalies is demonstrated, consisting of malformations with, at least partly, genetic background, and acquired disease as cerebral sequelae of altered cardiac hemodynamics (2).

REFERENCES

KEY WORDS: Fetus, MRI, cardiac malformation

Paper 19 Starting at 12:15 PM, Ending at 12:20 PM
Krabbe Disease with Enlargement of Optic Chiasm and Optic Nerves

Patel, B.1 · Gimi, B.1 · Agadi, S.2 · Koral, K.1
1University of Texas Southwestern Medical Center at Dallas, Dallas, TX, 2Children’s Medical Center of Dallas, Dallas, TX

PURPOSE
A case of Krabbe disease (globoid cell leukodystrophy) with optic nerve and optic chiasm hypertrophy is presented. The optic chiasm and prechiasmatic optic nerve sizes were compared with age-matched controls.

CASE REPORT
A 6-month-old (23.7 weeks) male presented with develop-
mental delay and hyperirritability. The noncontrast head CT showed mild symmetrical increased density in the thalami and caudate nuclei. MR imaging of brain demonstrated symmetrical T2 prolongation in the deep cerebral and cerebellar white matter and in the expected locations of the pyramidal tracts in the brain stem. Symmetrical T2 prolongation was present in the thalami, caudate nuclei and globi pallidi. The optic chiasm and optic nerves were larger than usual. The areas of the prechiasmatic optic nerves and optic chiasm were calculated using the T2-weighted coronal images. Compared with the values of age-matched controls, the areas were 245% and 156% greater for prechiasmatic optic nerves and optic chiasm, respectively. A diagnosis of Krabbe disease was made based on decreased galactocerebroside beta-galactosidase activity in leukocytes.

**IMAGING FINDINGS**

Krabbe disease is an inherited disorder transmitted in an autosomal recessive manner. The underlying abnormalities are various mutations of the gene for the lysosomal enzyme galactocerebroside beta-galactosidase, that cause accumulation of its precursor substrate, psychosine, which is toxic to the brain. Histologic examination demonstrates gliosis, lack of myelin, and the presence of globoid cells. The infantile form is most common and is universally fatal. CT and MRI findings of the case we present are consistent with those described in the early infantile form of Krabbe disease. Hypertrophy of the optic nerves and chiasm rarely is reported on imaging, although one of the five original cases described by Krabbe had enlarged optic nerves. Optic nerve enlargement has been suggested to be due to presence of globoid cells.

**SUMMARY**

To our knowledge we report the fifth case of Krabbe disease with hypertrophy of optic nerves and optic chiasm. Optic nerve and chiasm hypertrophy was confirmed by automated area measurements in the coronal plane as compared to age-matched controls.

**KEY WORDS:** Krabbe disease, globoid cell leukodystrophy, optic nerve

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**Paper 20 Starting at 12:20 PM, Ending at 12:25 PM**

**Pediatric Craniovertebral Junction Abnormalities Associated with Tracts**

Rea, D. J. P. 1  
Blaser, S. 1  
Drake, J. 1  
Shannon, P. 2  
Widjaja, E. 1

1 The Hospital for Sick Children, Toronto, ON, CANADA  
2 Mount Sinai Hospital, Toronto, ON, CANADA

**PURPOSE**

To describe the imaging findings of pediatric craniovertebral junction abnormalities associated with tracts.

**CASE REPORT**

Three cases of pediatric craniovertebral junction abnormalities with tracts are presented plus imaging of a postmortem fetal spine with a neuroenteric cyst at the craniovertebral junction. When bony abnormalities of the craniovertebral region are identified a thorough assessment for the presence of an associated tract should be performed. Craniovertebral lesions with a tract may be associated with neuroenteric cysts or fistulae producing brainstem compression, hydrocephalus or recurrent meningitis. Accurate identification of those craniovertebral junction abnormalities with tracts which have an associated cyst or fistula is vital as it defines potential surgical cases from those where no active management of the tract may be required.

**IMAGING FINDINGS**

Case 1: A 3-month-old child was imaged following staphylococcal meningitis. A gas-filled tract was identified at CT passing from the posterior wall of the oropharynx through the retropharyngeal soft tissues. The clivus was shortened and the anterior arch of C1 was dysgenetic. A hypodense lesion with mass effect upon the medulla was noted. Moderate hydrocephalus was identified also. The lesion was hyperintense to CSF on FLAIR sequences and did not enhance. Pathologic examination of the excised fistulous tract showed squamous epithelium representative of a neuroenteric cyst with a fistula between the cyst and the pharyngeal mucosa. Case 2: A 29-week preterm child with cleft palate and bifid tongue underwent MR brain which demonstrated a short clivus with absent central anterior arch of C1 and a CSF lined tract passing from the anterior spinal canal towards the pharynx through the bony defect. A subtle irregularity of the posterior wall of the oropharynx was noted at MR but no fistulous communication was subsequently proved. Pituitary duplication was noted. Case 3: A two-day old term child was referred for imaging for investigation of feeding difficulty and difficulty passing an NG tube. A persistent sphenopharyngeal canal with clefting of the central anterior arches of C1-C3 was noted. A thin tract of tissue was noted leading from the pons to the retropharyngeal soft tissues. A subtle irregularity of the posterior wall of the oropharynx was noted at MR but no fistulous communication was subsequently proved. Pituitary duplication was noted also. Case 4: Imaging of a postmortem specimen from a fetus which had undergone a termination at 19 weeks gestation was acquired. A central bony defect of the anterior arches of C1 was noted with a cystic mass extending between the spinal canal and the pharynx. Pathology demonstrated a neuroenteric cyst.

**SUMMARY**

Craniovertebral anomalies may be associated with tracts. Dedicated imaging protocols to assess for potential neuroenteric cysts or fistulae which may be seen in these disorders is recommended.

**REFERENCES**


**KEY WORDS:** Pediatric, craniovertebral, tract
Monday Morning

10:45 AM – 12:30 PM
Room 206/207

(4b) ADULT BRAIN: Degenerative, Demyelinating, Metabolic Diseases
(Scientific Papers 22 – 34)

See also Parallel Sessions
(4a) PEDIATRIC: Cerebrovascular, Congenital, Degenerative & Metabolic Diseases/Excerpta
(4c) ADULT BRAIN: Functional I
(4d) HEAD & NECK: Temporal Bone & Neck/Excerpta

Moderators: M. Matilde Inglese, MD
Mark C. Delano, MD

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Endosteal Hyperostosis: CT/MR Findings in the Neurocranium and Review of the Literature

Allmendinger, A. M. · Destian, S.
St. Vincent’s Catholic Medical Center
New York, NY

**Purpose**
Endosteal hyperostosis is a rare condition, inherited in either an autosomal recessive (Van Buchem type) or autosomal dominant (Worth type) pattern. It can affect all parts of the skeleton and usually presents in late childhood or at puberty with headache, progressive facial deformity and/or cranial nerve deficits. Although the association between endosteal hyperostosis, increased intracranial pressure and cranial nerve deficits has been reported in the radiology literature, the association of endosteal hyperostosis and tonsillar herniation has not.

**Case Report**
A 26-year-old female presented to the emergency room with an 18-month history of intermittent headaches and visual disturbances that “became worse in the past 4 days.” Past medical history was otherwise unremarkable and there was no history of trauma. Examination of the patient was significant only for bilateral papilledema and left nasal hemianopsia. Based on the imaging findings, the patient was started on corticosteroids and 3 days later had a left subtemporal decompression. She was discharged on the fifth postop day.

**Imaging Findings**
Initial noncontrast CT examination of the brain demonstrated diffuse hyperostosis of the calvarium with absence of the diploic space, enlargement of the left optic nerve, diminutive sulei, effacement of the basal cisterns and crowding of the cerebellar tonsils at the foramen magnum. An MR was obtained and demonstrated extension of the cerebellar tonsils 13mm below the foramen magnum, a partially empty sella turcica, hyperostosis of the calvarium with overall decreased marrow signal intensity (sclerosis) and bilateral optic disk edema.

**Summary**
Endosteal hyperostosis is an inherited disease. Transmission may be autosomal dominant or autosomal recessive. Both forms include endosteal sclerosis of the neurocranium and mandible, and loss of diploe. The Van Buchem type typically is associated with cranial nerve deficits and an empty sella turcica, and may have an elevated alkaline phosphatase. Conversely, the Worth type usually is not associated with cranial nerve deficits or an empty sella, and patients have a normal alkaline phosphatase. The Worth type, however, is associated with a more severely enlarged mandible. The differential diagnosis for generalized calvarial hyperostosis includes common conditions such as Paget’s disease, chronic anemia, hyperparathyroidism, chronic dialysis and acromegaly. Less common conditions include osteopetrosis, frontometaphyseal dysplasia and craniodiaphyseal dysplasia. In a young patient with calvarial hyperostosis and tonsillar herniation, endosteal hyperostosis should be considered.

**References**

**Keywords:** Hyperostosis, calvarium

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Monday Morning

10:45 AM – 12:30 PM
Room 206/207

(4b) ADULT BRAIN: Degenerative, Demyelinating, Metabolic Diseases
(Scientific Papers 22 – 34)

See also Parallel Sessions
(4a) PEDIATRIC: Cerebrovascular, Congenital, Degenerative & Metabolic Diseases/Excerpta
(4c) ADULT BRAIN: Functional I
(4d) HEAD & NECK: Temporal Bone & Neck/Excerpta

Moderators: M. Matilde Inglese, MD
Mark C. Delano, MD

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**Paper 22 Starting at 10:45 AM, Ending at 10:53 AM**

**Sodium MR Imaging of Patients with Multiple Sclerosis at 7 T: A Preliminary Study**

Inglese, M.1 · Oesingmann, N.2 · Johnson, G.1 · Nielles-Vallespin, S.3 · Stoeckel, B.2 · Sodickson, D.1 · Grossman, R. I.1 · Madelin, G.1
1New York University, New York, NY, 2Siemens Medical Solutions, New York, NY, 3Siemens AG Medical Solutions, Erlangen, GERMANY

**Purpose**
Multiple sclerosis (MS) is an inflammatory-demyelinating disease with pathologic involvement of neurons and axons(1). Pathologic and imaging studies have shown that neuro-axonal loss occurs progressively from the onset of disease, and that it correlates with disability. There is increasing
evidence that the intraaxonal accumulation of sodium ions may contribute to degeneration (2,3). In addition, partial blockade of sodium channels protects axons from degeneration in experimental models of MS, and it is currently under investigation in clinical trials (4). Sodium MR imaging (23Na MRI) provides an indicator of cellular and metabolic integrity and ion homeostasis and has been applied to the study of patients with brain tumors and stroke (5). The low sensitivity and spatial resolution of 23Na MRI make higher field strengths desirable to improve this imaging modality. The aim of this study was to optimize 23Na MRI at 7 T and investigate its feasibility in the study of patients with MS.

**Materials & Methods**

Three patients with MS (mean age 40±8.5 years) and three healthy controls (mean age 36±6.5 years) underwent 23Na MRI on a 7 T whole body imager equipped with multinuclei options (Siemens Medical Solutions, Erlangen, Germany). Approval for this study was obtained from the Institutional Board of Research Associates of New York University Medical Center and informed consent was obtained from all subjects. MR experiments were performed using a prototype single tuned 23Na unshielded TX-RX head coil (XLR Imaging Inc.) and a 3D GRE radial sequence. The pulse sequence’s parameters were: TR: 120 ms, TE: 0.05 ms, 1440 radial views, Flip Angle: 90°, 5 averages, BW: 130 Hz/pixel, FOV: 240 × 240 mm², matrix size: 60×60, nominal resolution: 4×4×4 mm³, Acquisition time: 14:26 min. Two calibration tubes with two different known concentrations of sodium (100 mM and 50 mM) in Agar gel 4% were placed in the FOV as references and allowed quantification of the sodium signal as a voxel-wise concentration.

**Results**

Good quality brain 23Na images were obtained in patients and controls. The specific absorption rate (SAR) was monitored in real time and was within FDA guidelines (<60% FDA limit). None of the subjects experienced side effects. For the patients, sodium hyper-intensity was observed in most of the lesions that were hypo-intense on T1-weighted images in line with the notion that these lesions are characterized by more severe tissue destruction. Serial studies and further patient recruitment is needed to investigate the dynamic of sodium changes in relation to disease activity and progression.

**Conclusion**

This study demonstrates the feasibility of 23Na MRI in MS at 7 T. Future studies will focus on the validation of sodium measurements in lesions and normal-appearing brain tissue in MS patients with different disease course and on development of methods to measure intra and extracellular sodium changes.

**References**

2. Waxman SG. *Brain* 2005

**Keywords:** Multiple sclerosis, neurodegeneration, sodium imaging

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**Paper 23 Starting at 10:53 AM, Ending at 11:01 AM**

**Prediction of Conversion from Clinically Isolated Syndrome to Clinically Definite Multiple Sclerosis Using Diffusion Tensor Imaging**

Jewells, V. L. · Chen, Y. · Speer, D. · Markovic-Plese, S. · Armao, D. · An, H. · Zu, H. · Bullitt, E. · Lin, W.

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**Purpose**

The ability to diagnose CIS patients who ultimately will convert to clinically definite multiple sclerosis (CDMS) would allow physicians to confidently begin immunomodulatory treatment to retard/prevent disease progression. Diffusion tensor imaging (DTI) detects white matter abnormalities in MS not detected with conventional MRI, and therefore has the potential to better classify MS patients. In this retrospective study, we hypothesized that DTI parameters would delineate white matter abnormalities in CIS patients and differentiate patients that ultimately would convert to CDMS from those who would not (NMS) using first time point MRI DTI.

**Materials & Methods**

This IRB-approved study with written informed consent sequentially recruited 34 CIS patients and 35 healthy control subjects. Images were acquired via 3D T1 MP-RAGE (isotropic voxels, 1mm3) and 6-direction EPI-DTI using a head-only 3 T MR scanner (Allegra, Siemens). All patients were followed for 2 years with physical exam, EDSS, relapse rate, and clinical conversion to CDMS (22) using McDonald criteria and NMS (12) groups. Bidirectional 3D B-spline registration T1 subject image warping towards a template constructed from controls, DTI affine patient registration to his/her respective T1 images, and patient group spatial normalization towards the common template for voxel-based statistical analysis (VBA) as well as histograms quartiles of DTI parameters were computed. For each patient, the volume of abnormal DTI white matter (VBAW) was computed by summing voxels deviating positively (ADC,L1,L2) or negatively (FA) more than two standard deviations from the normal (NORM) mean.

**Results**

Statistical findings of histogram and VAWM analyses are summarized in the table. All histogram quartiles of FA, ADC, L2 and the 3rd quartile of L1 demonstrate statistically significant differences between NMS and CDMS groups, while no statistically significant differences are seen between the NMS and NORM. VBA of all WM diffusion parameters demonstrated statistically significant differences between CDMS and NORM groups, but no statistically significant differences between NMS and NORM groups, while no similar significant areas were detected in NMS patients. Basal ganglia (BG) abnormalities in CDMS and NMS patients are identified; however, the DTI parameters reveal L1 is reduced significantly in only the NMS group.
CONCLUSION
Our results demonstrate that patients presenting as CIS who convert to CDMS within 2 years after initial presentation exhibit statistically significant different patterns of abnormal DTI statistics at first time point got with VBA and histogram analysis not seen in patients who do not convert to CDMS. In conclusion, our results strongly supported that DTI VBA can differentiate CDMS from NMS patients at first time point allowing for location specific demonstration of changes, and voxel specific information not available with histogram analysis.

KEY WORDS: Multiple sclerosis, diffusion tensor imaging, voxel based analysis

Paper 24 Starting at 11:01 AM, Ending at 11:09 AM
In Multiple Sclerosis, MR Imaging Abnormalities in the Corpus Callosum Are Specifically Correlated with Cognitive Disability

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PURPOSE
The corpus callosum (CC) commonly is affected in multiple sclerosis (MS). One frequently used outcome measure in MS clinical trials is the multiple sclerosis functional composite (MSFC), which includes the paced auditory serial addition test (PASAT)-3 as a measure of cognitive function. We hypothesized that magnetic resonance imaging (MRI) indices along the corpus callosum would be associated with PASAT-3 scores but not with motor or coordination components of the MSFC.

MATERIALS & METHODS
The study group consisted of 87 MS patients and 29 controls. Of the MS patients, 51 had MSFC performed within 30 days of the MRI. At 3 T, we used diffusion tensor imaging to reconstruct the CC. Restricted to the CC, we calculated fractional anisotropy (FA), measures of diffusivity, and from coregistered additional acquisitions we also calculated T2 relaxation time and magnetization transfer ratio (MTR). Pearson correlation coefficients were used to relate MRI findings to MSFC scores.

RESULTS
Median corpus callosum FA was lower, and mean diffusivity and T2 higher, in MS patients than in controls (t-tests, p<0.001). Tract profile analysis demonstrated that the greatest abnormalities were situated in the posterior body of the CC. In MS patients, PASAT-3 scores correlated with FA (r=0.50, p=0.0002), mean diffusivity (r=-0.40, p=0.002), and MTR (r=-0.46, p=0.0007). There were no significant correlations between MRI indices and other components of the MSFC (25 foot walk time and 9 hole peg test).

CONCLUSION
These results demonstrate that tract-specific MRI can be used to objectively monitor the neurologic underpinnings of specific functional deficits in MS. This type of imaging therefore can be used to follow patients in the clinic and to assess response to therapy in clinical trials.

KEY WORDS: Multiple sclerosis, DTI, corpus callosum

Paper 25 Starting at 11:09 AM, Ending at 11:17 AM
Measuring Myelin Repair with Diffusion Tensor Imaging
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PURPOSE
To evaluate the ability of diffusion tensor imaging (DTI) to measure remyelination following acute inflammatory injury. Conventional MR imaging detects the occurrence of inflammatory brain injury, but is a poor measure of the degree of injury and its later recovery. Diffusion tensor imaging has a broad dynamic range and good spatial resolution, and so is an attractive outcome metric of tissue injury. Animal models suggest that longitudinal diffusivity (λ1) is a marker of axonal injury, while transverse diffusivity (λ2) is a marker of myelin integrity. We sought to evaluate the ability of DTI to measure tissue recovery after acute injury, hypothesizing that (λ1) would decrease (from remyelination), leading to increased fractional anisotropy (FA).

MATERIALS & METHODS
Twenty multiple sclerosis (MS) patients were enrolled in a longitudinal natural history DTI study upon starting treatment with natalizumab, which is a strong antiinflammatory MS therapy. Imaging was performed on a 3 T Siemens Trio. Diffusion-weighted imaging used 71 noncollinear diffusion-weighting gradients (2.5 x 2.5 x 2.5mm voxels, b=2000sec/mm², 8 b=0 acquisitions). Anatomical imaging was performed for lesion detection and coregistration. Enhancing lesions at baseline were followed using FSL and AFNI software on monthly scans over 2 months. Average values within each region were derived for FA, mean diffusivity (MD), λ1, and λ2.

RESULTS
At baseline, nine patients demonstrated a total of 47 gadolinium-enhancing lesions. At both 1 and 2 months, average FA increased relative to baseline (p<0.001 for both comparisons, t-test), and average (λ1) decreased (p<0.05, p<0.01, respectively). Average MD and (λ1) values demonstrated no significant change over 2 months.
**CONCLUSION**

Longitudinal evaluation of gadolinium-enhancing lesions using DTI with high angular and spatial resolution suggests that DTI can detect brain tissue recovery following acute injury. The increase in FA and decrease in (λ₁) provides further evidence that these measures may represent remyelination.

Study supported by: Supported by K23NS47211 and NMSS RG3548 to RJF.

**KEY WORDS:** Multiple sclerosis, diffusion tensor imaging, remyelination

**Paper 26 Starting at 11:17 AM, Ending at 11:25 AM**

**Evaluation of Axial and Radial Diffusivity in Patients with Multiple Sclerosis**

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**PURPOSE**

Recent studies have demonstrated the ability of axial and radial diffusivity to distinguish between demyelination and axonal damage in a mouse model (1, 2). The purpose of the current exam was to evaluate the utility of these diffusion parameters in the evaluation of relapsing remitting and primary progressive multiple sclerosis (RRMS and PPMS).

**MATERIALS & METHODS**

Fifteen patients with MS (10/5 F/M, 5 with mild RRMS, 5 with severe RRMS, and 5 with PPMS) and 11 controls (all female) were scanned on Siemens Sonata or Trio (Erlangen, Germany). In addition to anatomical imaging the subjects were scanned with a multidirectional DTI sequence and with 4 different b-values (max 1200 mm²/s). The data were analyzed with a DTI model that is modified by the addition of a constant offset (CO) that is thought to represent a component of the signal that arises from highly constrained water molecules, and has been found to improve the representation of the data (3). The model parameters, including the CO, axial diffusivity, radial diffusivity, mean diffusivity (MD), and relative anisotropy (RA) were estimated using Bayesian probability theory (4). Regions of interest (ROI) were selected in the normal-appearing white matter of the centrum semiovale (NAWM) and corpus callosum (CC). In the patients with MS additional ROI were selected in chronic WM lesions identified on the T1- and T2-weighted images.

**RESULTS**

Within lesions there was uniform elevation of diffusivity measures and decrease in the RA and CO, proportional to the severity of the disease. In both the NAWM and the CC the MD show a positive correlative trend and the RA a negative correlative trend to disease severity, with differences as compared to the normal controls. In the NAWM both the axial and radial diffusivity were mildly elevated in the patients with higher disease severity. In the CC a similar pattern was seen with the axial diffusivity; however, the radial diffusivity was disproportionally elevated in the severely affected subjects as compared to the mild cases and the normal controls. This finding is consistent with myelin damage to the normal appearing CC, but not with axonal loss, as demonstrated in a mouse model of MS (1, 2).

**CONCLUSION**

Our results indicate that axial and radial diffusivity in addition to the CO may be useful parameters in the evaluation of RRMS and PPMS and could provide information that is more specific than that provided by routine MRI alone.

**REFERENCES**


Acknowledgements: Support provided by the National Multiple Sclerosis Society

**KEY WORDS:** Multiple sclerosis, DTI

**Paper 27 Starting at 11:25 AM, Ending at 11:33 AM**

**Diffusion Tensor Imaging Measures of Forniceal Injury Correlate with Episodic Memory Dysfunction in Multiple Sclerosis**

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Cleveland, OH

**PURPOSE**

The purpose of the present study is to investigate the relationship of diffusion tensor imaging (DTI) measurements of fornical injury to episodic memory dysfunction. An estimated 50% of patients with multiple sclerosis (MS) show cognitive impairment with 30-40% of MS patients demonstrating specific deficits in episodic memory. Recent pathologic data demonstrate significant hippocampal the demyelination in a subset of patients with MS; however, hippocampal white matter changes are difficult to evaluate using DTI due to the underlying structure of the hippocampus. The fornix is the primary efferent of the hippocampus and well suited for evaluation with DTI. The fornix has been strongly linked to memory function in a variety of disease processes. Recently, two studies have demonstrated DTI changes associated with memory deficit and Alzheimer disease. We hypothesize episodic memory dysfunction in MS patients will be correlated with fornical damage demonstrated by DTI changes, specifically, increased in axial diffusivity (λ₂) and reduced fractional anisotropy (FA).

**MATERIALS & METHODS**

Fourteen MS patients with relapsing remitting MS were studied using diffusion tensor imaging and a battery of neuropsychologic tests including the California verbal learning test (CVLT) and brief visual memory test (BVMT). Diffusion-weighted imaging used 71 noncollinear diffusion-weighting gradients (2.5x2.5x2.5mm voxels, b=2000sec/mm², 8 b=0 acquisitions). Anatomical imaging was performed for localization and coregistration of the fornix. Regions of interest were drawn in the crus of the fornix and average values for FA, mean diffusivity (MD), λ₂, and longitudinal diffusivity λ₁ were measured.

**RESULTS**

Verbal episodic memory dysfunction measured by the CVLT demonstrated a strong correlation with reduced FA (r=0.652,
p<0.01) and increased $\lambda_2$ ($r=-0.630, p<0.008$) within the left fornix. Interestingly, measures of spatial memory dysfunction, the BVLT demonstrated strong correlation with FA in the right and fornix ($r=0.766, p<0.001$). The figure depicts scatter plots for the DTI measures FA, $\lambda_1$ and $\lambda_2$ for the right side (red), left side (blue), and total (black) hippocampus as a function of CVLT and BVMT performance.

**CONCLUSION**
Deficits in episodic memory in MS subjects are strongly correlated with DTI measures of fornical damage. Findings suggest that DTI may provide a potential imaging biomarker for episodic memory dysfunction in MS.

**KEY WORDS:** Multiple sclerosis, diffusion tensor imaging, memory

**Paper 28 Starting at 11:33 AM, Ending at 11:41 AM**
Differentiating Multiple Sclerosis from Other Causes of Demyelination Using Diffusion-Weighted Imaging of the Normal-Appearing Brain

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**PURPOSE**
Differentiating between multiple sclerosis and other diseases affecting central nervous system (CNS) white matter can be diagnostically challenging on the basis of clinical presentation and conventional MRI. Abnormalities in diffusion-weighted imaging (DWI) have been described in multiple sclerosis patients, with higher apparent diffusion coefficients (ADCs) described in normal-appearing gray and white matter. The purpose of this study is to evaluate whether ADC values in gray and white matter brain regions differ in patients diagnosed with multiple sclerosis, a primary demyelinating disease, as compared to patients diagnosed with secondary demyelinating diseases such as neurosarcoïdosis and acute disseminated encephalomyelitis (ADEM).

**MATERIALS & METHODS**
Twenty patients diagnosed with clinically definite multiple sclerosis as defined by the Revised McDonald Criteria, 10 patients diagnosed with neurosarcoïdosis, and four patients diagnosed with ADEM underwent MR imaging including a diffusion-weighted sequence in a 1.5 T GE scanner. Multiple sclerosis patients included 10 males and 10 females with a mean age of 44 yrs (range = 23yrs to 72 yrs); non-MS patients included seven males and seven females with a mean age of 50 years (range = 16 yrs to 83 yrs). Quantitative analysis of data was performed on the Advantage Workstation using GE Functool software. Regions of interest (ROIs) were placed on axial images in the following locations: right, left and center in the genu of the corpus callosum, right, left and center in the splenium of the corpus callosum, right and left frontal and occipital white matter and both thalami. Care was taken to avoid placing ROIs in areas of visible T2 lesions whenever possible. Apparent diffusion coefficient values for each ROI were determined. A Student’s T-test was applied to compare patients with controls.

**RESULTS**
Mean ADC values were significantly higher in MS patients than in non-MS patients in the right (MS 1.1545, non-MS 0.8445, p=0.0007), center (MS 1.1555, non MS 0.9245, p=0.022), and left (MS 1.1750, non-MS 0.9007, p=0.011) of the genu of the corpus callosum and in the right (MS 1.0293, non MS 0.7378, p=0.000017), center (MS 1.045, Non MS 0.8114, p=0.000547) and left (MS 1.0620, non MS 0.7629, p=0.000013) of the splenium of the corpus callosum. In non-callosal white matter regions and gray matter regions, there were no statistically significant differences between MS and non-MS groups.

**CONCLUSION**
Elevated ADC levels within the corpus callosum on DWI may potentially help differentiate between patients with multiple sclerosis and patients with secondary demyelinating diseases affecting the CNS white matter.

**KEY WORDS:** Demyelination, diffusion-weighted imaging, multiple sclerosis

**Paper 29 Starting at 11:41 AM, Ending at 11:49 AM**
Variante Creutzfeldt-Jakob Disease: Quantitative Diffusion-Weighted Imaging In Vivo at 1.5 T and Ex Vivo at 9.4 T with Histopathologic Correlation

Hyare, H.1 · Thornton, J.1 · Powell, C.1 · Siddique, D.1 · Mancini, L.1 · Jager, R.1 · Wroe, S.1 · Brandner, S.1 · So, P.2 · Yousry, T.1
1Institute of Neurology, London, UNITED KINGDOM, 2Imperial College, London, UNITED KINGDOM

**PURPOSE**
Variant Creutzfeldt-Jakob disease (vCJD), caused by the same prion strain as that causing bovine spongiform encephalopathy (BSE), is a uniformly fatal disease which remains a significant public health issue. The WHO criteria for diagnosis of vCJD include the “pulvinar sign”: symmet-
rical bilateral thalamic high signal on T2-weighted and FLAIR but the neuropathologic significance remains uncertain. Diffusion-weighted imaging (DWI) is sensitive to changes in tissue microstructure and may offer objective markers for early diagnosis and monitoring in vCJD. The aim was to compare in vivo pulvinar apparent diffusion coefficients (ADCs) obtained in vCJD patients and controls, and to correlate ex vivo diffusion tensor imaging (DTI) results with histopathologic scores.

**Materials & Methods**

Eight patients with vCJD (3 female, 5 male, mean age 36.1 years, range 19-76) and 5 healthy volunteers (3 female, 2 male, mean age 41.2 years, range 33 - 52) underwent echo-planar DWI (b1000, TE101ms), T2-weighted and FLAIR at 1.5 T. Mean region of interest (ROI) ADCs for the pulvinar bilaterally and right frontal white matter were determined. Excised formalin-fixed pulvinar and frontal lobe specimens from six patients underwent high-resolution DTI at 9.4 T. Diffusion was measured along six nonlinear codirections (b factor of 1000 s/mm², TR 2000 ms, TE 22 ms). Maps of mean diffusivity (MD) and fractional anisotropy (FA) were calculated and ROIs drawn in the pulvinar nucleus, frontal gray and frontal white matter. Histologic processing was performed and the degree of gliosis, spongiosis and prion protein deposition in the pulvinar and frontal white matter were scored from 0-3 (3 most severe). The Mann-Whitney U test was used to assess differences between groups and Spearman rank correlation to assess relationships between DTI and histologic measures.

**Results**

All patients exhibited the pulvinar sign on conventional imaging and b1000 diffusion-weighted images. In vivo ADCs in the pulvinar were significantly higher in patients with vCJD than healthy volunteers (right: p=0.001; left: p=0.028). No significant frontal white matter ADC difference between the patient and control groups was observed. Correlations between ex vivo DTI measures and histopathologic scores were significant for FA and spongiosis, (r=0.926, p=0.008) and FA and gliosis (r=0.878, p=0.021). No significant associations between MD and the histologic measures were observed ex vivo. Significantly higher histologic scores for gliosis (p=0.008), but not spongiosis or prion protein deposition in the pulvinar compared to the frontal gray matter ROIs were noted.

**Conclusion**

Despite the hyperintensity seen on DWI, in vivo pulvinar ADCs were increased in vCJD compared with controls, suggesting that this pulvinar hyperintensity is a T2 effect, while histologic analysis demonstrated that gliosis in the pulvinar is likely to be the pathologic substrate. Correlations between ex vivo FA and histopathologic scores were negative for spongiosis and positive for gliosis, suggesting the latter may reinforce the directional organization of the neuropil. Future studies will determine the value of in vivo DTI metrics as pathologically specific indices of disease severity in vCJD.

**Key Words:** Prion, diffusion-weighted imaging, 9.4 T
matter volume decrease, or degeneration of the underlying white matter tracts. This suggests possible prefrontal cortical reorganization in PD patients with ExD. $^1$H-MRS may provide a surrogate marker for identifying patients who may benefit from targeted therapeutic strategies.

REFERENCES

KEY WORDS: Parkinson’s disease, spectroscopy, DTI

Paper 31 Starting at 11:57 AM, Ending at 12:05 PM
Intraarterial Autologous Implant of Adult Stem Cell for Patients with Parkinson’s Disease: Innovative Therapy

Brazzini, A. • Cantella, R. • Barreto, J. • De la Cruz, A. • Chilón, T. • Brazzini, M. • Jorquiera, T. • León, C. • Verde, K.
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Lima, PERU

PURPOSE
Adult stem cells have been proved to be a safe and effective form of potential cell therapy. An innovative therapy for Parkinson’s disease (PD) with autologous intraarterial implant of adult stem cells procedure is proposed.

MATERIALS & METHODS
A group of 47 patients are presented, 15 women and 32 men, who were 35 to 76 years of age and had PD (mean duration, 9 years). Patients were evaluated using a clinical exam, internationally recognized scales, MRI and SPECT. A bone marrow aspirate extracts stem cells, which then are processed using Rubinstein method. Three hours later they were intraarterially implanted in the posterior region of circle of Willis using intraarterial interventional radiology procedures. Patients were evaluated in their progress using neurologic evaluations, comparative scales, videos and MRI.

RESULTS
At 1 week patients had improved 38% in the UPDRS, at 1 month 52%, at 3 months 59% and at 6 months patients had improved 76%. No relationship was found between age and duration of disease or with overall improvement. Other scales also were used, results will be shown.

CONCLUSION
We consider this a highly recommended procedure because it has beneficial and effective results to all the treated patients, improving their symptoms, lowering drug use and obtaining independence. The role and training of the interventional radiologist is crucial for the success of this procedure because stem cells need to be implanted intraarterially. Additionally, no complications due to treatment have been found. What is more, many of the patients have achieved reinsertion in their daily and labor activities.

KEY WORDS: Parkinson’s disease, adult stem cell, therapy

Paper 32 Starting at 12:05 PM, Ending at 12:13 PM
Variant Creutzfeldt-Jakob Disease: Ex vivo Cytoarchitecture of Frontal Cerebral Cortex at 9.4 T

Hyare, H. • So, P. • Thornton, J. • Siddique, D. • Wroe, S. • Brandner, S. • Yousry, T.

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PURPOSE
Variant Creutzfeldt-Jakob disease (vCJD), caused by the same prion strain as that causing bovine spongiform encephalopathy (BSE), is a uniformly fatal disease which remains a significant public health issue. Cortical changes on MRI in vCJD have not been characterized extensively but histopathologically, the frontal cortex is where the hallmarks of vCJD: spongiosis, gliosis and prion protein deposition are evident. As magnetic resonance microscopy (MRM) at 9.4 T can resolve the horizontal lamination of the isocortex, the purpose was to exploit this technology to characterize the laminar pattern of the frontal cortex in excised formalin-fixed specimens from patients who died from vCJD and a non-CJD control group, and to compare results with histologic findings.

MATERIALS & METHODS
Formalin-fixed specimens from the frontal cerebral cortex from six patients who had died from vCJD (4 male, 2 female, mean age 41.6 years, range 19-76) and 6 non-CJD control subjects (1 male, 5 female, mean age 68.6, range 47 - 86 years) were imaged at 9.4 T (Varian Inc., Palo Alto, CA). High-resolution (78 micron in-plane) T2-weighted images were acquired (TE 24ms, TR 2400ms, FOV 40mm x 40mm, matrix 512 x 512, slice thickness 1mm, 20 averages) with a total acquisition time of 7 hours. Following MR imaging, 1 vCJD and 1 control specimen were selected and the fixed tissue incubated in 98% formic acid for 1 h and following further washing for 24 h in 10% buffered formal saline, tissue samples were processed, paraffin wax-embedded and stained with Nissl stain for microscopic evaluation. T2-weighted signal intensity profiles were generated perpendicular to the cortical surface, from deep to superficial areas, to more clearly depict differences between vCJD and control specimens.

RESULTS
Visual inspection of high-resolution T2-weighted images of the frontal cortex revealed, in all six control specimens, an intracortical laminar structure with a low signal intensity layer corresponding to layer IV of the cortex. However, in five of six vCJD specimens, there was apparent loss of the
intracortical laminations with homogenous signal intensity across the cortex. In the remaining vCJD specimen the intracortical structure was attenuated but not completely absent. The cortical signal intensity profiles revealed a focal dip in intensity corresponding to layer IV in all six control specimens while for five of six vCJD cases the cortical signal intensities exhibited a smoother profile. The Nissl staining performed in two of the specimens revealed attenuation of the intracortical structure in vCJD due to neuronal loss where there was spongiosis and prion protein deposition.

CONCLUSION
Ex vivo MRM at 9.4 T can depict pathology characteristic of vCJD by demonstrating apparent loss of the normal intracortical laminations. These observations will be increasingly relevant as high-field MRI systems with improved spatial resolution enter clinical practice, when in vivo assessment of the cerebral cortex may prove highly beneficial in the diagnosis and monitoring of vCJD.

REFERENCES

KEY WORDS: Prion, cytoarchitecture, 9.4 T

Paper 33 Starting at 12:13 PM, Ending at 12:21 PM
Evaluation of Brain Morphology and Topology in Huntington’s Disease: Preliminary Results

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PURPOSE
Huntington’s disease (HD) is a neurodegenerative disease associated with a progressive damage to basal ganglia and cortical thinning. Recently, pattern of cortical atrophy has been studied noninvasively using MRI and has been well correlated with some clinical symptoms and with cortical thickness (cTHK) postmortem measures (1). In HD, it was suggested that the cortical atrophy progresses in posterior-anterior direction. In the present work we study the cortical folding patterns of cerebral cortex in several cases of HD. We hypothesize that the modification of the cortical gyriﬁcation could precede the gray matter loss.

MATERIALS & METHODS
Four preclinical and one clinical HD patient’s brains were examined on a 3 T Philips Achieva MR system using a high-resolution 3D magnetization prepared T1-weighted sequence (α/T1/TR/TE: 8°/1040/10/5 ms), providing good contrast between gray (GM) and white matter (WM). The images were processed using FreeSurfer (2) and the measures of total WM, GM, CSF, deep GM nuclei, and cerebellum were obtained, after the subject head size was accounted for. Additionally, absolute cTHK and folding density (cFD) for 33 Brodmann areas also were analyzed. The same measures were obtained from 10 or more age-matched subjects selected from the literature-based brain morphometry study (3) and used as reference for each of them.

RESULTS
The youngest preclinical HD patient showed volume reductions of both pallidum, as well as thinning and change in cFD of the cuneus. In three older preclinical HD patients we conﬁrmed the atrophy of the basal ganglia, but without noticeable trend, and increased volume of the ventricular system. The frontal, temporal, pre and postcentral cTHK were in the range of the age-matched control subjects. However these patients showed identical pattern of atrophy involving superior parietal, lateral occipital, cuneus, pericalcarine, and lingual cortices. Additionally, these subjects demonstrated signiﬁcantly modiﬁed cFD of orbito-frontal and prefrontal cortices. The patient with a clinical HD showed severe loss of both cerebral and cerebellar WM and GM with a substantially dilated ventricular system. The volumes of all deep nuclei of the basal ganglia were reduced considerably with respect to age-matched controls. Global thinning and cFD changes of the cortical ribbon accompanied the severe stage of the disease.

CONCLUSION
The measures of cortical and subcortical atrophy in our HD subjects with various severity of the disease are coherent with the published literature (1). Additionally, we observe that the cortical folding density is altered in preclinical HD in regions with preserved cortical thickness. Despite the ongoing debate about the exact nature and behavior of the cFD, in our experience, its value shows only minimal variation in control subjects (3). In other words, cortical folding patterns seem very well defined in the normal aging population and an alteration of cFD may indicate ongoing pathologic processes associated with HD. Therefore, studying the modification of cortical gyriﬁcation could help to better understand this disease.

REFERENCES
2. FreeSurfer; https://surfer.nmr.mgh.harvard.edu/fswiki

KEY WORDS: Atrophy, Huntington’s disease, cortical folding

Paper 34 Starting at 12:21 PM, Ending at 12:29 PM
Wernicke’s Encephalopathy: MR Findings in 53 Alcoholic and Nonalcoholic Patients

Zuccoli, G.1 · Santa Cruz, D. M.2 · Rovira, A.3 · Gallucci, M.4 · Santelli, L.5 · Carlolo, C.6 · Bertolini, M.7 · Capellades, J.8
1Arcispedale Santa Maria Nuova, Reggio Emilia, ITALY, 2Hospital Italiano, Buenos Aires, ARGENTINA, 3IDI Vall D’Hebron, Barcelona, SPAIN, 4Hospital S Salvatore, L’Aquila, ITALY, 5Azienda Ospedaliera, Padova, ITALY, 6IDI, Hospital Germans Trias i Pujol, Badalona, SPAIN

PURPOSE
The present study was undertaken to analyze and compare findings on MR imaging and neurologic symptoms at clinical presentations of patients with Wernicke’s encephalopathy with and without a history of alcohol abuse.

MATERIALS & METHODS
A retrospective multicenter study group reviewed the MR findings and clinical records of 53 Wernicke’s encephalopa-
thy (WE) patients (29 male, 27 female, mean age of 50.5 years, range 6-86 years) diagnosed between 1999 and 2007. Twenty-four patients were alcoholics (AL) and 29 patients were nonalcoholics (NA). Patients were identified from a search of diagnostic data bases from various hospitals. Charts were reviewed for clinical history, symptoms at presentation, imaging modalities, and neuroradiologic findings. Inclusion criteria consisted of a clinical diagnosis of WE and improvement at clinical presentation within 1 month from the beginning of thiamine administration. Imaging findings showed symmetric signal intensity alterations involving the thalamus, periventricular region of the third ventricle, periaqueductal area, mamillary bodies, tectal region, cerebellum and cranial nerve nuclei (facial, abducens and hypoglossal nuclei). We compared the two patient population with the Fisher exact test.

RESULTS
Twenty-five patients (47%, 14 NA vs 11 NA) showed the classical triad of the disease (ocular abnormalities, ataxia and consciousness changes). Forty-one patients showed signal intensity alterations of the thalamus (27 NA, 14 AL). Thirty-two patients showed alterations of the periaqueductal area (21 NA, 11 AL). Twenty-three patients showed alterations of the mamillary bodies (15 NA, 8 AL). Thirteen patients showed alterations of the tectal plate (11 NA, 2 AL). Seven patients showed alterations of the cranial nerve nuclei (7 NA, 0 AL). A statistical positive correlation was found between the NA patient population and the cranial nerve nuclei selective involvement (P=0.01, phi=0.355). A statistical positive correlation was found between the NA patient population and the tectal plate involvement (P=0.013, phi=0.342). Contrast enhancement of the mamillary bodies, thalami and periaqueductal showed a statistical positive correlation with the AL population (respectively P=0.004 phi=0.393, P=0.047 phi=0.273, P=0.021 phi=0.317). A T2-weighted normal signal intensity associated with contrast enhancement in regions typical for the disease was found in seven patients (13%, 1 NA, 6 AL).

CONCLUSION
In this study we showed that alcoholic and nonalcoholic patients patterns of presentation differ in MR imaging. Selective cranial nerve nuclei alteration is a typical finding in nonalcoholic patients. Contrast enhancement in the mamillary bodies, thalami and periaqueductal area is a typical finding in alcoholic patients. To explain our findings we have speculated that cranial nerve nuclei are more sensitive to a rapid decline in thiamine concentration, and that blood-brain barrier disruption is increased by chronic alcohol abuse.

REFERENCES

KEY WORDS: Nutritional and metabolic diseases

Monday Morning

10:45 AM – 12:30 PM
Room 208/209

(4c) ADULT BRAIN: Functional I
(Scientific Papers 35 – 47)

See also Parallel Sessions
(4a) PEDIATRIC: Cerebrovascular, Congenital, Degenerative & Metabolic Diseases/Excerpta
(4b) ADULT BRAIN: Degenerative, Demyelinating, Metabolic Diseases
(4d) HEAD & NECK: Temporal Bone & Neck/Excerpta

Moderators: Meng Law, MD
Jeffrey R. Petrella, MD

Paper 35 Starting at 10:45 AM, Ending at 10:53 AM
Lead Exposure during Childhood Disrupts Adult Brain Metabolism

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PURPOSE
Despite numerous studies demonstrating an inverse association between blood lead levels and cognitive functioning, academic performance, and social behaviors, structural neuroimaging evaluations of children and adults with low-to-moderate lead exposure (US EPA action level 10 µg/dL) are generally unremarkable. However, magnetic resonance spectroscopy (MRS) evaluations of lead-exposed populations may provide distinct metabolic information useful for refining the mechanistic models of lead-induced brain injury. We hypothesized that adults with childhood lead exposure would demonstrate evidence of irreversibly altered neural metabolism, specifically via reductions of N-acetyl aspartate (NAA).

MATERIALS & METHODS
Adult participants (N=159, mean age 20.8 years) of a longitudinal birth cohort studying the effects of low-to-moderate lead exposure completed a quantitative, short-echo spectroscopy protocol evaluating seven brain regions. Metabolite concentrations were determined with corrections applied for cerebrospinal fluid contribution to the voxel. Correlation and multiple regression analyses were used to investigate the relationship between regional metabolite concentrations and mean childhood blood lead levels. Blood lead levels were measured every 3 months for the first 5 years of life and
Results
Higher mean childhood blood lead levels were associated with reduced metabolite concentrations. After adjusting for the impact of age and full scale intelligence quotient (FSIQ), increases in mean childhood blood level correlated with concentration reductions of NAA (p=0.02) and Creatine (Cr) (p=0.01) in the basal ganglia, NAA (p=0.05) and Choline (Cho) (p=0.04) in the cerebellar hemisphere, glutamate and glutamine composite (GLX) (p=0.02) concentration in the vermis, Cho (p=0.02) and GLX (p=0.02) in parietal white matter and Cho (p=0.02) in frontal white matter were observed.

Conclusion
This study of young adults with low-to-moderate childhood lead exposure demonstrates a significant association between mean childhood blood lead levels and regional brain metabolite concentration levels. Gray matter changes may indicate a developmental insult occurred. White matter abnormalities suggest alterations to myelin structure. These neutral alterations may be responsible for the cognitive and behavioral changes attributed to lead exposure.

Key Words: Lead exposure, spectroscopy

Paper 36 Starting at 10:53 AM, Ending at 11:01 AM
Diffusion Tensor Analysis of Adults with Significant Childhood Lead Exposure

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Purpose
Childhood lead exposure is associated with adverse social behaviors and reduced measures of intelligence and motor function. One manner in which lead exposure alters brain development occurs via injury to oligodendrocytes and astrocytes. The ability of glia to respond to oxidative stress likely disrupts myelin architecture. The extent of white matter injury associated with lead exposure and the corresponding functional consequences remain unclear. We hypothesized that childhood lead exposure ultimately alters adult white matter structure. We employed diffusion tensor (magnetic resonance) imaging (DTI) to explore white matter injury from lead exposure in an environmental cohort followed from birth to adulthood.

Materials & Methods
Participants provided informed consent for the IRB-approved study. High-resolution, volumetric T1-weighted (MPRAGE, TR/TE 2000/2.93 ms, slice thickness 1 mm) and 12-direction diffusion tensor images (spin-echo EPI, TR/TE 6000/87 ms, b-value 1000 s/mm², slice thickness 2 mm) were acquired with a 3T MR scanner from adult participants (N=94, 40 men) of a longitudinal birth cohort studying the effects of low to moderate lead exposure. Fractional anisotropy was measured in two approaches: 1) a voxel-wise manner and 2) in regions of interest (ROIs) including the genu of the corpus callosum (gCC), posterior limb of the internal capsule (PLIC), superior fronto-occipital fasciculus (SFO), and superior longitudinal fasciculus and centrum semiovale (SLF+CS). Regions of interest were drawn manually on a composite normalized T1-weighted image. Blood lead levels were measured every 3 months for the first 5 years of life and every 6 months from 5 - 6.5 years of age. The individual mean of these 23 childhood blood lead assessments was employed. Statistical analyses of DTI measures were performed with multiple regression analyses employing the mean childhood blood lead as the covariate of interest with the evaluation of confounders such as age at imaging, sex, birth weight, gestational age, adult socioeconomic status, full-scale IQ, maternal IQ, and prenatal exposure to cigarettes, alcohol and marijuana.

Results
Significant reductions for fractional anisotropy in association with increasing mean childhood blood lead levels were observed diffusely in white matter, primarily within the predefined ROIs.

Conclusion
This study reveals a diffuse reduction of fractional anisotropy values throughout white matter. Young adults with low-to-moderate childhood lead exposure demonstrate significant associations between mean childhood blood lead levels and measures of white matter integrity afforded via DTI. These white matter alterations may be responsible for the adverse cognitive and behavioral changes attributed to lead exposure.

Key Words: Lead exposure, white matter, fractional anisotropy

Paper 37 Starting at 11:01 AM, Ending at 11:09 AM
Relationships between Exercise and Cerebral Blood Flow in Older Adults

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Purpose
The human brain undergoes cognitive decline and physical changes such as volume loss with aging. Vascular changes such as altered vessel number or capacity may be at fault. Aerobic exercise prevents vascular disease elsewhere in the body, but its effects are unclear in the brain. Exercise has been shown to increase brain volume and cognitive function in the elderly, and better cerebral blood flow(CBF) may be the cause. This study aimed to test the hypothesis that resting CBF is higher in older adults who exercise as compared to those less active.

Materials & Methods
Fourteen healthy adults 60-80 years old were recruited. Eight were active in aerobic sports greater than 3 hours per week for over 10 years (Active Group). Six had less than 1 hour of aerobic sport exercise per week for the last 10 years (Inactive Group). MR images were acquired with a Siemens head-only 3.0 T MRI unit. Continuous arterial spin labeling
sequences (TR=4000, TE=16ms) were used to measure CBF. Statistical Analysis: Matlab software was used to calculate CBF images and volume standardized histograms for each subject. The mean, mode, and median of each histogram were calculated and the two groups compared by T-test and variance F-test.

RESULTS

The inactive CBF histograms are more heterogeneous than those of the active group (Figure). The mean, mode, and median were not statistically different between the two groups, but the variances of those measures were significantly higher in the inactive group (Table).

![Cerebral Blood Flow Histograms](image)

Table: Active & Inactive Subject CBF Comparison

<table>
<thead>
<tr>
<th></th>
<th>Active</th>
<th>Inactive</th>
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<tbody>
<tr>
<td>CBF (mL/100g/min)</td>
<td>Average</td>
<td>Variance</td>
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<tr>
<td>Mean</td>
<td>35</td>
<td>43*</td>
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<td>Mode</td>
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<td>37*</td>
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<tr>
<td>Median</td>
<td>32</td>
<td>40*</td>
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* Statistically different between the two groups. (p<0.05)

CONCLUSION

Active subjects did not have higher resting CBF than inactive subjects; however histogram analysis revealed more homogeneous flow. This can be expected as poor cardiovascular health can increase as well as decrease CBF. Cardiac disease and generalized atherosclerosis decrease CBF, but heterogeneous vessel narrowing in the brain may cause hypoperfusion in affected areas with compensatory hyperperfusion elsewhere. Orthostatic hypotension and respiratory issues such as sleep apnea also increase supine cerebral perfusion. Maintaining CBF within a healthy range is important for brain health. Extremes may increase the risk of ischemia or hemorrhagic stroke. An aerobic exercise program may be a vital part of healthy aging by normalizing cerebral perfusion.

KEY WORDS: Perfusion, exercise, aging

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Paper 38 Starting at 11:09 AM, Ending at 11:17 AM

**Reduction in Cortical Metabolism and Cerebral White Matter Integrity in Aging Brains: FDG PET and MR DTI Analysis**

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PURPOSE

Investigations of age-related metabolic changes have indicated frontofractal dysfunction (1). Recent analysis of cerebral morphology as well as diffusion tensor imaging (DTI) of white matter integrity has revealed age-related decline in frontofractal white matter (2). This study is to investigate if frontofractal dysfunction can be related to underlying white matter abnormality. We compared correlations of both white matter integrity and cortical metabolism to age in normal mid-age to elderly subjects.

MATERIALS & METHODS

Brain MR and PET data were obtained from subjects recruited in a longitudinal aging study (n=25, 13 men, age 48 - 88 yrs.). Standard brain PET imaging (GE Advance) was performed after intravenous injection of 10 mCi [F-18]fluorodeoxyglucose (FDG) at rest in a quiet room. MR imaging was performed on a 3 T scanner (Philips Achieva Dual Quasar gradient system) with an 8 channel sense head coil. T1-weighted (T1W) scans, 3D MPRAGE pulse sequence, were acquired (TR/TE/Flip/ = 6.6ms/3ms/8; 1mm
acquired voxel size; inversion time = 850ms; T1 recovery time = 3s; Sense factor of 2 in slice direction). Axial DTI of the whole brain was performed using 32 gradient directions (10mm
voxel size, b=1000s/mm
2, TR/TE/Flip/nex 9.609s/64ms/90/1; sense factor = 2 in phase direction; EPI bandwidth = 1870Hz.). FA maps were generated using DTIstudio software (Version 2.3, Johns Hopkins University). Following coregistration of PET, T1W, and FA image sets in each subject, all image sets were registered stereotactically using nonlinear warping and normalized (NEUROSTAT, University of Washington). Voxel-wise linear correlation maps (converted to z values) were generated between age versus cortical glucose metabolism (FDG), micro-white matter disruptions (FA), and global cortical loss (T1W) with controlling Type I error rates based on a random Gaussian model. Pixels with significant correlation with age were localized in stereotactic coordinates.

RESULTS

Cortical glucose metabolism showed significant age-related reduction (p<0.05) in frontotemporal structures including inferior and middle frontal gyri (Z=5.3), anterior superior temporal gyrus (Z=4.8), medial frontal gyrus (Z=4.2), and insula (Z=5.3). In contrast, there was relative preservation within the precentral and postcentral gyri and basal ganglia. Age-related reduction in white matter integrity was observed predominantly in frontotemporal regions with peak reductions localized to inferior frontal lobe (Z=5.8), uncinate fasciculus (Z=4.4), anterior commissure (Z=4.2), anterior corpus callosum (Z=4.1), and cingulum (Z= 4.0). T1-weighted images indicated significant age-related atrophy in the medial frontal lobe (Z=4.9) and peri-Sylvian region (Z=4.2).
CONCLUSION
This study demonstrated age-related metabolic reductions in the frontotemporal regions with extensive underlying changes in white matter integrity. This finding indicates a potential association of frontal cortical and subcortical dysfunction in the aging process. These changes are in contradistinction to evidence established in our laboratory and by others of posterior involvement in Alzheimer disease, indicating differential underlying biological processes. The mechanistic relationship between cortical and subcortical changes is under further investigation.

REFERENCES

KEY WORDS: Aging, MRI, PET

Paper 39 Starting at 11:17 AM, Ending at 11:25 AM
Quantitative Analysis of Resting State Oscillatory Rhythms in the Healthy Adult Brain

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PURPOSE
With development of the highly sensitive synthetic aperture magnetometry (SAM) algorithm for magnetoencephalography (MEG), more regions of transient MEG activity are detected, some of which reflect normal brain rhythms. Our purpose is to quantify activity seen in brains of nonepileptic adults while undergoing resting MEG.

MATERIALS & METHODS
Magnetoencephalography was recorded from eight healthy adult volunteers using a 275-channel whole-head biomagnetometer. Active electrode coils were placed at fiducial points and were digitized to allow for MEG MRI coregistration. Up to 11 2-minute recordings were made with most subjects progressing from resting awake, through drowsy and sleeping states. Third order gradiometer technology was used to reject strong distant sources (such as cardiac electrical activity). Postprocessing was limited to Dc-offset correction and 1Hz cutoff high-pass filter to eliminate drift. Peaks of magnetic activity were determined by evaluating r.m.s. magnetic activity and were characterized in terms of amplitude. An automated spatial filtering and spike detection algorithm (SAM) identified regions of transient MEG activity. These regions are overlaid on the MRI as statistical probability maps of activity. Virtual depth electrodes were placed at these locations to identify the time-activity profile at these sites. Quantitative analysis was performed.

RESULTS
In all subjects, mu rhythm activity was seen in perirolandic regions bilaterally, and alpha rhythm activity was seen in parieto-occipital lobes bilaterally when subjects eyes were closed. In 99% of 2 minute runs, mu and alpha activity were seen exceeding a peak t-statistic of 0.1. Increasing the threshold to 1.0 decreased incidence to 53% for mu and 68% for alpha. Mean mu: 1.26 (range: 0.0-5.9, SD: 0.99). Mean alpha: 1.37 (range: 0.0-4.3, SD: 0.77). Gender differences were observed in mu activity, with the mean significantly higher for males than females (1.97 v 0.62, p<0.01). No significant laterality differences were observed, and no gender differences were seen in alpha activity.

On left, mu activity in normal subject; on right, patient with epileptogenic focus in left perirolandic region. Note marked difference in t-statistics.

CONCLUSION
Resting MEG monitoring in nonepileptic subjects reproducibly demonstrated quantifiable mu and alpha rhythm activity. This establishes initial thresholds of quantitative normal values in the adult brain. The high sensitivity of SAM in detecting normal brain rhythm should not result in misidentification as an ictal onset zone. If values seen in epilepsy patients exceed this threshold, evaluation of time-domain data, and construction of synthetic depth electrodes to examine morphology of brain activity is warranted.

KEY WORDS: MEG

Paper 40 Starting at 11:25 AM, Ending at 11:33 AM
Blipped Phase-Encoding: A Different Approach to Speed Up MR Spectroscopic Imaging

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PURPOSE
Proton MR spectroscopic imaging (MRSI) is often hampered by long scan times, particularly if high spatial resolution and coverage are required. Recently, scan time reductions in MRSI have been demonstrated using parallel imaging techniques such as SENSE. This abstract revisits an alternative method, blipped phase-encode (BPE), for speeding up MRSI, and compares it to both conventional and SENSE MRSI.

MATERIALS & METHODS
In BPE, alternative positive and negative blipped phase-encode gradients are applied between success time domain points in the time-domain readout. Sampling rate (receiver bandwidth) is double compared to that of a conventional MRSI acquisition, while the total experimental time (the total number of conventional phase-encoded gradients) is halved. Experimental demonstration of BPE MRSI was performed on phantoms and on a healthy normal volunteer using a slice-selective, spin-echo multi-slice MRSI experi-
RESULTS
Spectral quality and metabolic images were very similar between conventional and BPE scans, with the average SNR in the conventional MRSI experiment being 18.9±5.7 (mean±standard deviation) and 13.6±5.5 in the BPE MRSI, which is approximately 72% of the conventional experiment. This is in close accordance with the expected value of 70.7%, based on the two-fold reduction in scan time. Figure shows the phantom comparison between BPE and SENSE MRSI. It can be seen that both methods work well in the axial and sagittal planes.

CONCLUSION
BPE is a viable alternative to SENSE for scan time reduction in MRSI. It can be used under conditions where SENSE-encoding is unfavorable, such as single-coil systems, or multi-coil systems with unfavorable geometries.

Acknowledgement: Supported by NIH P41RR015241.

KEY WORDS: Spectroscopic imaging, brain
is a reliable technique to map language tracts in patients with brain lesions. In one patient, the arcuate fasciculus could not be reconstructed although stimulations were positive suggesting that negative tractography does not rule out the persistence of a fiber tract.

**KEY WORDS:** Language, DTI, intraoperative

**Paper 42 Starting at 11:41 AM, Ending at 11:49 AM**

Norman E. Leeds Award - Perfusion Imaging in Brain Tumors: Value of Perfusion Cerebral Blood Volume Measurements in Predicting Time to Progression/Outcome in Gliomas Compared with Histopathologic Assessment

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**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 de-differentiate 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 (HGGs and LGGs) irrespective of pathology and specifically whether gliomas with high initial CBV show more rapid progression than those with low CBV.

**MATERIALS & METHODS**

One hundred eighty-nine patients with histologically proved glioma comprising of low-grade astrocytoma (LGA, n=28); LG oligodendroglioma (LGO, n=14); LG oligoastrocytoma, n=11; anaplastic astrocytoma (AA, n=72), anaplastic oligodendroglioma (AOA, n=12), and glioblastoma multiforme (GBM, n=52) were studied with dynamic susceptibility contrast perfusion MRI (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**

Dynamic susceptibility contrast 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:** Perfusion imaging, brain tumors

**Paper 43 Starting at 11:49 AM, Ending at 11:54 AM**

Rare Neuroimaging and Neuropathologic Diagnostic Dilemma: Neonatal Alexander Disease, with or without Malignant Astrocytic Neoplasm?

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Royal Oak, MI

**PURPOSE**

Alexander disease is a rare leukodystrophy resulting from the abnormal intracytoplasmic accumulation of intermediate filaments in astrocytes usually due to de-novo autosomal dominant mutation of the glial fibrillary acidic protein (GFAP) gene. The imaging and pathologic characteristics of typical cases of this entity have been well characterized. However, in the past a few cases have presented with neuroimaging and/or neuropathologic findings that were concerning for a neoplastic process. In 2005, van der Knaap described several such patients. Other authors have reported gliomas associated with Alexander disease. Such cases show a florid proliferation of astrocytes and the presence of mitotic figures; features that are morphologically associated with neoplastic processes. Such cases raise a very difficult neurol imaging and neuropathologic differential diagnosis; are these cases simply florid examples within the spectrum of Alexander disease, or do they represent neoplastic astrocytic proliferations in the setting of Alexander disease?

**CASE REPORT**

We describe a patient with both neuroradiologic and neuropathologic features concerning for malignancy. Our patient presented at 2 months of age with progressively increasing head size, worsening irritability, failure to achieve milestones, and a bulging anterior fontanel. DNA analysis confirmed the presence of a heterogenous missense mutation of E383K which has been reported previously in association with Alexander disease. Ultimately our patient was felt to have neuroimaging and neuropathologic features most consistent with neonatal Alexander disease, but the possibility of neoplasm could not be excluded entirely. Follow up of this case is ongoing.

**FINDINGS**

Neuroimaging: CT revealed bilateral symmetrical hypopattemation of frontal lobe white matter and asymmetric dilatation of the lateral ventricles with sparing of the anterior horns. On MRI, features characteristic of Alexander disease included hydrocephalus, predominantly frontal lobe white matter signal abnormalities and pathologic enhancement.
The possibility of neoplasm was entertained given mass-like enlargement of the tectum. Brain MRA was normal. MR spectroscopy revealed markedly elevated choline, decreased NAA, and elevated lactate, excluding Canavan disease. Neuropathology: The white matter and to a lesser degree the cortical ribbon revealed diffuse infiltration by atypical astrocytes with strikingly abundant intracytoplasmic granular Rosenthal fiber-type material. Scattered mitotic figures and an elevated proliferative fraction were present. Scattered atypical astrocytes showed convincing nuclear staining for p53. The neuropathologic, genetic and neuroimaging features were interpreted as most consistent with Alexander disease. The possibility of grade III astrocytoma (essentially gliomatosis cerebri given extensive involvement of the brain) could not be excluded entirely, but was considered to be much less likely.

**Summary**

This case reveals the diagnostic dilemma that Alexander disease may present on neuroimaging and neuropathologic examination. Rare cases of gliomas have been described in the setting of Alexander disease. It is our hope that this case will highlight some of the less common features of the Alexander disease spectrum.

**Key Words:** Alexander disease, neonatal, astrocytoma

**Paper 44 Starting at 11:54 AM, Ending at 12:02 PM**

**Grading of Oligodendroglial Tumors of the Brain with Apparent Diffusion Coefficient, MR Spectroscopy and Dynamic Susceptibility Contrast Imaging**

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University of Rochester
Rochester, NY

**Purpose**

Gliomas can be classified as astroglial, oligodendroglial or oligoastrocytoma based on the cell population. The incidence of oligodendroglial and tumors with an oligodendroglial component is rising due to improved histopathologic techniques. The prognosis is dependent on the WHO grade. Grade 3 oligodendroglioma (OIII) or oligoastrocytomas (OAIH) has worse prognosis than Grade 2 oligodendroglioma (OII) or oligoastrocytoma (OAIH). It is difficult to differentiate them on conventional imaging. The purpose of our study was to investigate if apparent diffusion coefficient (ADC), metabolite ratios or dynamic susceptibility contrast (DSC) could aid in the differential diagnosis of the different grades of oligodendroglialomas.

**Materials & Methods**

From our data base, we searched the patients with oligodendroglial component. Forty patients matched our criteria and were found to have advanced imaging. There were 23 patients in WHO grade II or group 1 (16 patients of OII and 7 patients of OAII) and 17 patients were in grade III or group 2 (13 patients of OAIH and 4 patients of OIII). Diffusion-weighted images (TR/TE/NEX, 10000/125/1; B= 1000) were acquired before injection of intravenous contrast. MR spectroscopy was acquired having water saturation with point resolved saturation (PRESS) with TE of 144 or 30. 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 relative permeability surface (rPS) maps thus were reconstructed. The rCBV and ADC values were normalized to contralateral white matter. Mann-Whitney Test was used to test the significance of the results.

**Results**

Maximum rCBV of grade II (22 patients) and grade III tumor (16 patients) was found to be 2.17 ± 1.66SD and 2.84 ±1.69 SD respectively. Mann-Whitney test showed no significant difference between the two groups with p-value of .122. However the rPS max was found to be low in the low grade oligodendrogliol lesions which were showing high rCBV. When the rPS max obtained from the dynamic susceptibility maps was combined to the rCBV max , there was a significant difference between the two groups (p < 0.03). Apparent diffusion coefficient of grade II (22 patients) and grade III tumor (13 patients) was found to be 1.40 ± .322SD and 1.206 ±.425 SD respectively. There was no statistical difference between the two groups with p-value ≤.121.Choline/creatinine ratio of grade II (12 patients) and grade III tumor (10patients) was found to be 2.98 ± 2.7SD and 3.06 ±1.67 SD . Choline/NAA ratio of grade II (12 patients) and grade III tumor (10 patients) was found to be 3.06± .1.67SD and 5.06 ± SD respectively. There was no statistical difference between the two groups with p-value ≤.722 & ≤.582. The lactate peak was found in 25% of low grade group and 50% of high grade group.

**Conclusion**

The rCBV max and rPS max combined together are helpful in grading of oligodendrogliol tumors. The rCBV maximum, minimum ADC and metabolic maps although showed some difference between them but none of the modality alone showed a statistical significant difference in between the two groups.

**Key Words:** MR perfusion, apparent diffusion coefficient, oligodendrogioma

**Paper 45 Starting at 12:02 PM, Ending at 12:10 PM**

**Comparison of Tumor Metabolism and Tumor Blood Volume in Recurrent Gliomas at Time of Progression**

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**Purpose**

To compare glioma grading based on tumor metabolism, as measured by uptake of fluorodeoxyglucose (FDG) by positron emission tomography (PET) with grading based on tumor blood volume, as measured by dynamic susceptibility contrast bolus tracking MRI (DSC-MRI).

**Materials & Methods**

Fifty-six patients (35 male, 21 female) with previously treated gliomas (33 Grade IV, 20 Grade III, and 3 Grade II) were enrolled into a treatment protocol at the time of tumor recurrence defined clinically by a combination of all imaging and clinical findings. This study retrospectively examines the baseline F-18 FDG PET and DSC-MRI, both of which were performed within 2 weeks prior to initiation of therapy.
Fluorodeoxyglucose PET was performed using a 2D acquisition approximately 1 hour following injection of approximately 10 mCi F-18 FDG. Bolus tracking was performed using 2D FE EPI (TR 1500-2300 ms) at 1.5 T or 3 T during a rapid injection of a single dose of contrast. The relative cerebral blood volume (rCBV) was estimated by the negative enhancement interval during bolus passage. A preinjection of a single dose was performed approximately 10-15 minutes prior to bolus tracking to eliminate confounding effects of contrast leakage on rCBV estimates. The PET and rCBV data were graded separately but in conjunction with T1-weighted postcontrast imaging. Grading was based on the region of maximal uptake or rCBV that corresponded to enhancing tissue on T1-weighted postcontrast imaging. A visual grading scale based on gray (GM) and white matter (WM) levels was used for both FDG PET uptake and DSC MRI rCBV. Levels less than WM were assigned to 1, approximately equal to WM to 2, between GM and WM to 3, approximately equal to GM to 4, and greater than GM to 5. Three neuroradiologists performed each assessment on two separate occasions. Intrarater and interrater reliability were analyzed using Spearman Rho and Kendall’s W respectively. Agreement between the maximum FDG uptake and rCBV was assessed using Bland-Altman analysis.

RESULTS

Both PET intrarater reliability (Spearman Rho 0.87, p < 0.0001) and MRI intrarater reliability (Spearman Rho 0.72, p < 0.0001) were high. Interrater reliability for PET (Kendall’s W 0.88, p < 0.0001) and MRI (Kendall’s W 0.82, p < 0.0001) were both very high and comparable. Bland-Altman analysis showed some lack of agreement between PET grade (4.12 ± 0.77) and MRI grade (4.47 ± 0.57), but this was not significantly different.

CONCLUSION

Tumor metabolism and tumor blood volume have both been shown to correlate with tumor grade. In this study, we directly compared FDG PET and DSC MRI in the same tumors and demonstrated that these two techniques provide similar assessments of tumor grade in the context of glioma recurrence/progression. The grade of tumors was similar for both FDG PET and DSC MRI consistent with a fundamental association between tumor vascularity and metabolism. Practically, FDG PET grading is somewhat more consistent, association between tumor vascularity and metabolism. FDG PET and DSC MRI consistent with a fundamental

Key Words: MR perfusion, PET, gliomas
CONCLUSION
The maximum, mean and minimum rCBV of lymphomas were significantly less than GBM and metastases. The mean values of rCBV of lymphomas also were significantly less than the enhancing grade 3 tumors. The mean rCBV of enhancing tumors can differentiate the CNS lymphoma from other malignant brain tumors.

KEY WORDS: MR perfusion, CNS lymphoma, enhancement-perfusion mismatch

Paper 47 Starting at 12:18 PM, Ending at 12:26 PM
Quantitative Diffusion Tensor Imaging for Evaluation of Motor Function in Patients with Brain Infarcts

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PURPOSE
We speculate that the disruption and degeneration in CST would correlate with motor disability after cerebral ischemic stroke. Our purpose is to evaluate the quantitative diffusion value in ipsilateral cerebral peduncle of patients with different motor function ability, and to explore anisotropy threshold in predicting worse motor function disability.

MATERIALS & METHODS
Diffusion tensor imaging was performed on 27 patients with 9 to 222 days after middle cerebral artery (MCA) territory ischemic stroke on a GE Signa 3 T scanner. The motor function ability of these patients was evaluated with Twitchell-Brunnstrom standard (6 grades, grade 1 to 6, from worst to best) from 6 to 9 months after stroke onset. FA and trace apparent diffusion coefficient (trace ADC) values in the ipsilateral cerebral peduncle were calculated. Patients were divided into three groups as group 1 with Brunnstrom grade 1 or 2; group 2 with grade 3 or 4; group 3 is with grade 5 to 6. The difference of mean FA and trace ADC values among 3 groups, the correlation of mean FA value with motor function ability grades and the cutoff FA value for differentiating patients with grade 1 or 2 from patients with grade 3 to 6 were analyzed with SPSS15.

RESULTS
There was significant difference of mean FA value (0.373±0.06, 0.497±0.04, 0.617±0.05; from group 1 to 3) in ipsilateral cerebral peduncle among 3 groups (P=0.000, by ANOVA test). The correlation between mean FA value and Brunnstrom grades also is significant (P=0.000, by Spearman’s correlation test). Discriminant analysis and leave-one-out validation approach were employed, 88.9% patients could be classified correctly with Brunnstrom grade 1 and 2 as FA value threshold of 0.488. (Figure) There is no significant difference of trace ADC among groups and correlation with Brunnstrom grades (P>0.05).

CONCLUSION
Our result showed that the quantitative FA value in the ipsilateral cerebral peduncle of CST correlated well with the motor function in the patients with MCA ischemic stroke; FA may be useful in individualized rehabilitation therapy and early predicting motor outcome.

KEY WORDS: DTI, motor function, infarction

Monday Morning
10:45 AM – 12:30 PM
Room 211/212
(4d) HEAD & NECK: Temporal Bone & Neck/Excerpta
(Scientific Papers 48 – 62)

See also Parallel Sessions
(4a) PEDIATRIC: Cerebrovascular, Congenital, Degenerative & Metabolic Diseases/Excerpta
(4b) ADULT BRAIN: Degenerative, Demyelinating, Metabolic Diseases
(4c) ADULT BRAIN: Functional I

Moderators: Suresh K. Mukerji, MD
Richard H. Wiggins, III, MD
Superior Semicircular Canal Dehiscence: Congenital or Acquired Condition?

Nadigir, R.1 · Devaiah, A.1 · Halderman, A.2 · Sakai, O.1
1Boston University Medical Center, Boston, MA, 2Boston University School of Medicine, Boston, MA

PURPOSE
Superior semicircular canal dehiscence is a condition characterized by onset of vestibular symptoms in the setting of loud noises, thought to occur as a result of the “third window” phenomenon within the inner ear. Although most patients present in middle age, it is unclear whether this condition is congenital or acquired. The purpose of this investigation is to assess prevalence of superior semicircular canal dehiscence on imaging among multiple age groups to determine whether this condition is more likely congenital or acquired.

MATERIALS & METHODS
Following IRB approval, 240 consecutive temporal bone CT examinations performed for a variety of clinical indications between July 2005 and March 2007 on a 64 detector-row scanner with 0.625 mm axial collimation were reviewed retrospectively; coronal and sagittal 0.3 mm thick reformats were performed at the workstation at the time of retrospective analysis. Two cases were eliminated due to destructive malignant processes in the inner ear, yielding a final number of 238 patients (476 temporal bones). Images were evaluated independently by two neuroradiologists blinded to age, gender and clinical presentation, and the superior semicircular canal was characterized as normal, thin, or frankly dehiscent in each temporal bone. Results were tabulated, and any discrepancies were resolved by consensus. The patient list then was subcategorized into five age groups; 0-20, 21-40, 41-60, 61-80, and 81-100 years. The prevalence of superior semicircular canal dehiscence was calculated for each age group.

RESULTS
An increased prevalence of superior semicircular canal dehiscence was seen with increase in age (Table 1). Poisson regression was used to test for trend in increasing prevalence across age categories. Prevalence increased by 65% for each age category [rate ratio 1.65, 95% CI (1.04-2.60)], p=0.03, statistically significant.

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Total number of patients</th>
<th>Number of patient with canal dehiscence</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>31</td>
<td>1</td>
<td>3.2</td>
</tr>
<tr>
<td>21-40</td>
<td>76</td>
<td>5</td>
<td>6.6</td>
</tr>
<tr>
<td>41-60</td>
<td>92</td>
<td>8</td>
<td>8.6</td>
</tr>
<tr>
<td>61-80</td>
<td>35</td>
<td>6</td>
<td>17</td>
</tr>
</tbody>
</table>

CONCLUSION
The increased prevalence among older age groups supports the impression that superior semicircular canal dehiscence is more likely an acquired rather than congenital condition.

KEY WORDS: Dehiscence

3D DRIVE in Inner Ear Pathology

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Penn State Hershey Medical Center
Hershey, PA

PURPOSE
To illustrate the ability of 3D DRIVE (driven equilibrium RF reset pulse) sequence, target maximum intensity projection and 3D volume reconstruction in depicting the anatomical details and pathology of inner ear, internal auditory canal (IAC) and cerebellopontine angle cistern.

MATERIALS & METHODS
Thirty-nine patients (26 males, 13 females) who were clinically diagnosed as sensorineural hearing loss underwent routine MRI study for IAC followed by a 3D DRIVE sequence. 3D DRIVE sequence provides a T2-weighted contrast with high fluid signal than turbo spin-echo (TSE), shortens the total scan time and reduces the flow artifacts. This study was performed on 3T MR scanner (Achieva, Phillips Medical System). DRIVE sequence parameters were: TR 2000 ms, TE 200 ms, FOV 180, matrix 300X168 with voxel size 0.58x1.07, slice thickness of 0.75 mm over contiguous and with total acquisition time of 4 minutes 30 seconds. DRIVE data was postprocessed on AQNET. The MIP cut planes and 3D volume reconstruction was performed. The MIP cut planes were obtained with standard coronal and sagittal orientation. Target MIP coning the inner ear and IAC also were carried out.

RESULTS
The axial images provided excellent anatomical details in all the patients. Thin 3D DRIVE axial images and MIP cut plane reconstruction proved to be complimentary modality in assessing the inner ear structures and vestibule-cochlear nerve. Details of cochlea, modiolus, the osseous spiral lamina and the content of vestibule, saccule and utricle were reliably depicted. Author found MIP very useful in depicting the membranous tubule structure in single view. Twenty-four patients did not reveal any pathology; however the inner ear structure details were appreciated better on DRIVE sequence. Four patients showed inner ear congenital malformation. Eleven patients had either CP angle or internal auditory canal pathologies (like acoustic schwannoma, meningioma, epidermoid and arachnoid cyst). DRIVE sequence in all these patients showed clear delineation of neural anatomy and tumor extension. Mass effect and encasement of the adjacent upper (Vth) and lower (VII, IX & XII) cranial nerves were demonstrated better.

CONCLUSION
Data from our study suggest that integrity and microstructure of inner ear can be evaluated better with 3D DRIVE sequence. Excellent spatial resolution with 3D DRIVE sequence facilitates the detail evaluation of tubular structures and increase in understanding of their functions and role in normal hearing and sensorineural hearing loss.

KEY WORDS: 3D DRIVE, inner ear
Dilated Dysplastic Vestibule: A New CT Finding in Patients with Large Vestibular Aqueduct Syndrome

Emmrich, J. V. · Fatterpeker, G. M. · Anderson, J. E. · Delman, B. N. · Oyfe, I. · Ando, K. · Law, M. · Naidich, T. P. · Som, P. M.
Mount Sinai Medical Center New York, NY

Purpose
Large vestibular aqueduct syndrome (LVAS) accounts for approximately 12% of children who present with congenital sensorineural hearing loss. A vestibular aqueduct (VA) measuring greater than 1.5 mm in diameter is considered diagnostic for LVAS. We speculated that an enlarged VA would be associated with a dilated dysplastic vestibule. The purpose of this study was to evaluate the volume of the vestibule in patients with LVAS and compare it to normal individuals.

Materials & Methods
A retrospective CT analysis of six patients with LVAS was conducted. The CT scans of each individual side of the temporal bone were analyzed for the diameter of VA at the external aperture near the cerebellopontine angle cistern, at its midportion, and at the opening of the aqueduct into the vestibule. Volume of each individual vestibule was measured on TeraRecon Aquarius Workstation v3.3. The vestibular volume measured by coregistering the axial, coronal, and sagittal images then was projected on a 3D reconstructed image of the vestibule to correct for oversampling or undersampling of the data. Similar measurements of the VA and the vestibule were obtained in an age-matched control population (n = 46). Statistical analysis was carried out using Mann-Whitney U test to compare volume of the vestibule in the LVAS patients versus the normal population. Pearson’s correlation coefficient was used to assess for any linear relationship between the VA and the enlarged vestibule in patients with LVAS. Paired t-test was used to compare the volume of the vestibule between the right and the left side in the normal individuals.

Results
Since the frequent simultaneous occurrence of LVAS in both ears suggests a dependent relationship between the two sides, the results were interpreted with comparison of the right ear of the patients with LVAS versus right ear of the normal individuals. Similar analysis was carried out to assess the left ear. In the control group, the vestibular volume was measured as 0.037 ± 0.006 cc, and 0.038 ± 0.006 cc on the right and left sides respectively. There was no statistically significant difference in the two sides in the normal population (p = 0.20). In the LVAS group, the vestibular volume was measured as 0.053 ± 0.015 cc, and 0.056 ± 0.018 cc on the right and left sides respectively. A statistically significant difference in the volume of the vestibule was noted on comparison of the individual ears in the LVAS group versus the normals (right ear p <0.0001, and left ear p <0.0001). A linear relationship between an enlarged VA and corresponding increase in the volume of the vestibule could be demonstrated only with respect to correlation of the diameter of the distal opening of the VA into the vestibule (right side p <0.05 and left side p <0.01).

Conclusion
Dilated dysplastic vestibule is strongly associated in patients with LVAS. This either reflects a co-dysplastic phenomenon or probably reflects a cause-effect relationship supporting the theory of a pressure wave injury to the membranous labyrinth of the cochlea by an increased endolymphatic flow.

Key words: Large vestibular aqueduct syndrome, vestibule, CT

Cochlear Enhancement Following Translabyrinthine Surgery

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University of Utah Salt Lake City, UT

Purpose
MR imaging is being used more frequently in the evaluation of temporal bone pathology. One example of this is the number of patients undergoing translabyrinthine surgery for the resection of acoustic schwannomas and other cerebellopontine angle masses near the internal auditory canal. Serial examinations following these patients after surgery are also increasingly common and are used to evaluate for both residual and recurrent disease. This study was undertaken to describe the as yet unreported appearance of the cochlea following specifically, translabyrinthine surgery.

Materials & Methods
Eight patients evaluated at varying intervals following translabyrinthine surgical approach with gadolinium-enhanced MR examination were reviewed retrospectively. The appearance of the cochlea adjacent to the translabyrinthine surgical bed in each of these patients was evaluated on both pre and postgadolinium contrast-enhanced images and compared to the contralateral nonoperative (presumably normal) cochlea. The presence or absence of intrinsic T1 signal and enhancement was assessed and comparison to preoperative imaging was performed when studies were available.

Results
All patients demonstrated marked enhancement of the cochlea adjacent to the translabyrinthine surgical bed following the administration of gadolinium. Cochlear enhancement commonly is associated with multiple nonsurgical etiologies including infection, inflammation, hemorrhage, radiation, and tumor. The presence or absence of recurrent or residual tumor is of paramount importance in this patient population. We believe that the presence of cochlear enhancement following translabyrinthine surgery is an exceedingly common and normally expected imaging finding that should not be mistaken for tumor recurrence. Many histopathologic explanations for this enhancement are possible and likely are related to the time interval at which the patient is imaged following surgery. Most investigators agree, however that the final pathway following labyrinthine insult, whether from infection, inflammation, or surgery, is fibrosis. Whether this fibrosis is a result of arterial ligation, cochlear nerve sacrifice and subsequent absence of neurotropic factors, direct labyrinthine trauma, or inflammatory mediators remains a matter of debate.
CONCLUSION
A retrospective review of the MR imaging findings in a series of eight patients following translabyrinthine surgery demonstrates enhancement of the cochlea which is a normally expected postoperative finding that should not be confused with residual tumor or recurrence of disease. We propose that the histopathologic etiology of enhancement is related directly to the presence of fibrous tissue invasion of the cochlea as a result of surgical intervention.

KEY WORDS: Cochlea, cochlear enhancement, postoperative

Paper 52 Starting at 11:17 AM, Ending at 11:25 AM
Atresia of the External Acoustic Meatus in the Skull of “la Chapelle aux Saints”

Badawi Fayad, J.1 · Nguyen, T. H.2 · Belleville, M.3 · De Lumley, M. A.1 · Iba Zizen, M. T.2 · Cabanis, E. A.3

PURPOSE
Anatomical comparison and 3D virtual endoscopy of the right and left auditory system to define the atresia of the left external acoustic meatus of a Neanderthal male, found at la Chapelle aux Saints, in the southwest of France.

MATERIALS & METHODS
We have acquired a CT volume of the skull of a Neanderthal male, cumulating 0.6 mm thick slices for 2D and 3D reconstructions. Virtual endoscopy of the surface of the skull were reconstructed, for comparison of the right and left external acoustic meata. Measurements of the heights and widths of the external, middle and internal ears as well as density histograms in the tympanic cavities were compared.

RESULTS
The ossicles of the right tympanic cavity were removed, so that comparison of right and left ossicles was not possible. Comparative measurements of the right and left auditory systems confirmed a narrowing the left external meatus. This narrowing was associated with a thickening of the anterior and posterior walls of the temporal bone and a bony plate at the location of the tympanum. The left tympanum cavity showed a reduced height. Structures of inhomogeneous high densities filled up the mesotympanum, the epitympanum and the vestibule, with densities inferior to bony structures. Homogeneous bone densities centrally located in the left tympanic cavity suggested a malleus and an incus of small dimensions. The stapes was not clearly delineated. All the structures of the labyrinth and the inner ear were of normal size. There was no significant evidence of osteosclerosis of the left mastoid cells.

CONCLUSION
In the “la Chapelle aux Saints” skull, we could measure precisely the aural atresia of the left external acoustic meatus, due to a temporal bone thickening and a bony plate. The left tympanic cavity probably presented hypoplastic ossicles, with delineation of the malleus and the incus. The high densities filling up the mesotympanum and epitympanum might correspond to matrix because of a inhomogeneous density, lower to that of bone structures. The normal shape of the cochlea and the semicircular canals with no significant osteosclerosis of the mastoid cells, was not in favor of chronic otitis.

KEY WORDS: Anthropology, aural atresia, CT

Paper 53 Starting at 11:25 AM, Ending at 11:33 AM
Imaging of Petromastoid Canal in Children on High-Resolution Temporal Bone MR Imaging

Koral, K. · Suter, E. · McMenamy, J. · Fernandes, N. · Sayre, J. · Booth, T.
University of Texas Southwestern Medical Center at Dallas Dallas, TX

PURPOSE
To describe the MRI characteristics of petromastoid canal (PMC, also known as subarcuate canal) in children.

MATERIALS & METHODS
Four hundred eighty-five high-resolution temporal bone MRI studies performed for clinical indications were evaluated retrospectively. Twelve patients with dysplastic semicircular canals were excluded. There were 264 males and 209 females. The mean age was 6.50 years (0.16-18.09 years, standard deviation ± 4.51). Measurements were made on the axial T2-weighted images. The patients were separated into 3 age groups (group I: <1 year; group II: ≥1year and <2 year; group III ≥2 year).

RESULTS
The PMC was visualized most frequently in children younger than 1 year (26/60 on right, 24/60 on left; 43.3% and 40.0%, respectively). The detection rate of PMC decreased precipitously after 1 year [in group II: 6/35 (17.1%) on right, 2/35 (5.7%) on left; in group III: 8/377 on right (4.8%), 8/377 on left (2.1%)]. There was moderate to large dependency to age in detection of PMC (Cramers V coefficient of contingency was 0.534 for left and 0.427 for right, p<0.001). The mean size of the PMC decreased with age (p<0.001).

CONCLUSION
MR imaging characteristics of PMC were not described previously. Familiarity with the normal appearance of PMC on high-resolution MRI is important for pediatric temporal bone imagers. In younger children, the PMC is relatively large and is detected more frequently. With increased pneumatization of the mastoid air cells, after 1 year of age the PMC detection rates decrease.

KEY WORDS: Petromastoid canal, subarcuate canal, MRI
Paper 54 Starting at 11:33 AM, Ending at 11:38 AM

Posterior Semicircular Canal Dehiscence by the Jugular Bulb: An Unusual Cause of Tinnitus

Ksar, J. S. · Jain, R. · Shah, K. · Patel, S. C. · Pace, M. Henry Ford Hospital Detroit, MI

PURPOSE
To describe the imaging features and clinical presentation of posterior semicircular canal dehiscence (PSCD) by the jugular bulb.

CASE REPORT
A 35-year-old female presented with complaints of “whooshing noise in right ear sequential with her pulse” suggesting pulsatile tinnitus. Tinnitus worsened when she would lie on her right side and she also had a feeling of pressure. The patient denied any vertigo or hearing loss. Examination showed the tympanic membrane and external auditory canal to be normal. No hearing deficit was detected and reflexes were normal. CT temporal bone was performed for further evaluation.

IMAGING FINDINGS
High-resolution CT of the temporal bones revealed a high rising right jugular bulb with a small bony defect between the inferior aspect of the right posterior semicircular canal and the jugular bulb. Coronal and oblique sagittal reformats also demonstrated the bony dehiscence of the inferior aspect of the posterior semicircular canal.

SUMMARY
Posterior semicircular canal dehiscence (PSCD) has been described recently as an unusual cause for inner ear symptoms of vertigo, hearing loss and tinnitus in addition to the previously known entity of superior semicircular canal dehiscence which usually presents with vertigo and ‘Tullio’s phenomenon (1). In a small series, 7% of patients with inner ear symptoms had PSCD identified on temporal bone CT (1). The majority of patients presented with vertigo while tinnitus and hearing loss were less common symptoms. Hence, it is important for a radiologist to be aware of PSCD as a potential cause of vertigo or rarely tinnitus, as in the present case, for diagnostic and treatment purposes.

REFERENCES

KEY WORDS: Semicircular canal dehiscence, high rising jugular bulb, tinnitus

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Paper 55 Starting at 11:38 AM, Ending at 11:43 AM

X-Linked Mixed Hearing Loss: Multidetector CT Findings Old and New

Mani, K. L. · Moonis, G. · Cunnane, M. E. · Curtin, H. Beth Israel Deaconess Medical Center, Boston, MA, Massachusetts Eye and Ear Infirmary, Boston, MA

PURPOSE
X-linked mixed hearing loss (DFN3) is a nonsyndromic, hereditary disease. Two as yet undescribed high-resolution multidetector CT (MDCT) findings in this disorder are presented, and other MDCT findings reviewed.

CASE REPORT
We analyzed 12 temporal bones in six male patients (ages 2 months - 67 years) using a 40 detector MDCT (Siemens).

IMAGING FINDINGS
Findings included enlargement of the internal auditory canal, absence/hypoplasia of the lamina cribrosa and modiolus, hypoplasia of the middle and apical turns of the cochlea, absence of the interscalar septae, and enlargement of the facial canal and the vestibular aqueduct. Additionally, fusiform enlargement of the lateral and superior semicircular canals (Figure 1) and an anomalous, medial course of the labyrinthine facial canal (Figure 2) were noted, neither of which has been described previously in association with this disease.
SUMMARY

The normal cochlea acts as a medial barrier to the developing facial nerve canal. When it is hypoplastic, the labyrinthine facial canal can take an anomalous course medially, accounting for our MDCT finding. X-linked mixed hearing loss has been associated with mutations in the POU3F4 gene (DFN3 locus) of the x-chromosome. POU3F4 is part of a family of transcription factors involved in terminal neuronal differentiation, and is highly expressed in the inner ear. Abnormalities of the otic capsule mesenchyme have been observed, which may relate to the semicircular canal enlargement seen in our cases. It is crucial for radiologists to understand the spectrum of MDCT findings in x-linked mixed hearing loss, not only to raise the concern for hereditary transmission and facilitate the evaluation of family members, but also to avoid complications including “stapes gusher” (perilymph and cerebrospinal fluid otorrhea) during middle ear surgery.

REFERENCES


KEY WORDS: X-linked mixed hearing loss, DFN3, stapes gusher

Paper 56 Starting at 11:43 AM, Ending at 11:51 AM

Who are Stenver and Poschl Anyway? The How and Why of Temporal Bone Transverse and Longitudinal Oblique CT Reformats

Hutchins, T. A. · Quigley, E. · Salzman, K. · Wiggins, R. · Harnsberger, H. R.

University of Utah
Salt Lake City, UT

PURPOSE

Neuroradiologists are comfortable in approaching the temporal bone CT from the traditional axial and coronal planes. However, the complex, oblique and curvilinear orientation of many temporal bone structures make full characterization difficult on these orthogonal views alone. Although it is possible to reformat images into any plane to address a specific clinical question, the associated additional time requirement can be prohibitive in a busy clinical setting. We introduce a new technique for radiologist-independent acquisition of longitudinal and transverse CT reformats of the temporal bone, formerly known as Stenver and Poschl views. We also aim to identify structures better seen, structures previously unseen, and structures best measured on these additional views.

MATERIALS & METHODS

Fifty temporal bone CTs, obtained and reformatted 0.5 mm - 0.75 mm intervals, were reviewed retrospectively by two independent CAQ neuroradiologists. Axial images and coronal, longitudinal oblique, and transverse oblique reformatted images were reviewed. All reformats were created independently by a CT technologist. Using a rating system, a comprehensive set of normal temporal bone structures were scored for visibility in each plane. Visibility ratings were analyzed for differences between imaging planes. Additionally, raters plotted oblique reformat planes on the axial images, which were later compared to actual planes chosen by the technologist. Rater’s scores were compared and evaluated for reproducibility.

RESULTS

Longitudinal oblique reformats scored significantly higher for visualization of the following structures: bony vestibular aqueduct, facial nerve relative to the lateral semicircular canal, malleoincudal joint, singular nerve canal, bony eustacian tube, tensor tympani muscle and tendon. These views depict the anatomical relationships of the epitympanum, additus ad antrum, mastoid antrum, tegmen tympani and tegmen mastoidium on a single image. They also scored best for determining number of cochlear turns and identifying the
previously unseen Bill’s bar associated with the en face view of the superior vestibular and labyrinthine facial nerve canals. Transverse oblique reformats scored significantly higher for visualizing the superior semicircular canal and arcuate eminence, as well as the oval and round windows. They provided en face views of the bony vestibular aqueduct. Scores were reproducible between raters. Reformat planes chosen by raters and by CT technologists were not significantly different (P<.05).

CONCLUSION
Longitudinal and transverse oblique CT reformats of the temporal bone can be created reliably and independently by a CT technologist. These views improve the clinical utility of the CT exam at no additional radiation cost to the patient through improved visualization of multiple clinically relevant structures. Previously nonvisualized structures, such as Bill’s bar can be seen on these oblique images. Finally, they provide en face and longitudinal views of multiple normal structures, creating optimal views for measurement of the internal auditory canal, bony vestibular aqueduct and superior vestibular canal.

KEY WORDS: Temporal bone, CT, oblique

Paper 57 Starting at 11:51 AM, Ending at 11:56 AM

Venous Cause of Facial Canal Enlargement: HRCT and Histopathologic Correlation

Mani, K. L. · Moonis, G. · Cunnane, M. E. · Merchant, S. · Curtin, H.

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

PURPOSE
The purpose of our study is to present a previously undescribed cause of bony facial nerve canal enlargement on high-resolution multidetector CT (HRCT) due to an enlarged vein.

CASE REPORT
Histopathologic specimens from a cadaver were stained, and sections examined by light microscopy. Specimen temporal bone HRCT was performed using a 40-detector Siemens scanner and processed on a 3D (Voxar) workstation.

IMAGING FINDINGS
High-resolution multidetector CT demonstrated fusiform enlargement of the bony facial nerve canal from the geniculate ganglion to the stylomastoid foramen without osseous erosion (Figure 1). The foramen spinosum was present. Histopathologically, the canal contained the facial nerve and a similar sized vein running parallel to it (Figure 2). No abnormal artery or mass lesion of the facial nerve was noted.

SUMMARY
The differential diagnosis for enlarged facial canal on HRCT includes developmental variants such as persistent stapedial artery and meningocele, as well as pathologic processes like schwannoma, hemangioma, and perineural spread of neoplasm, amongst others. Venous causes of facial canal enlargement have only been rarely mentioned in the literature (1). Middle meningeal artery branches (superficial petrosal and superior tympanic arteries, traveling with the greater and lesser superficial petrosal nerves) run alongside the facial nerve in its geniculate and tympanic segments (2). In our case, the venous structure enlarging the facial canal likely represents confluence of the veins accompanying these named arteries. A persistent lateral capital vein enlarging the facial canal also has been described previously in one report (1). Being aware of the venous etiologies of facial canal enlargement can help prevent unnecessary workup and intervention in asymptomatic patients.

REFERENCES

KEY WORDS: Facial canal, enlargement, vascular
CT Classification for Otosclerosis

Lee, T. C. · Aviv, R. I. · Fox, A. J. · Chen, J. M. · Nedzelski, J. M. · Symons, S. P.
Sunnybrook Health Sciences Centre
Toronto, ON, CANADA

PURPOSE
To ascertain the number of cases of otosclerosis in the data base of a referral hospital for hearing loss, and determine if a classification system for otosclerosis proposed by Symons and Fanning (1) has high interobserver consistency.

MATERIALS & METHODS
Review of all petrous bone CT studies on the PACS system of a tertiary hospital was performed which included 997 studies from December 2000 to September 2007. The severity of otosclerosis was graded independently by two observers in a blinded fashion, and compared. The appearance of the otic capsule was graded as follows: grade 0, normal; grade 1, solely fenestral; grade 2, patchy localized retrofenestral disease (with or without fenestral involvement) to either the basal cochlear turn (grade 2a) or the apical/mid turn (grade 2b) or to the basal turn and the apical/mid turn (grade 2c); and grade 3, diffuse confluent retrofenestral involvement (with or without fenestral involvement).

RESULTS
Eighty-one patients with CT findings of otosclerosis were identified. One hundred sixty-two temporal bones were graded with 156 agreements (96% interobserver agreement) identified. One hundred sixty-two temporal bones were identified. Eighty-one patients with CT findings of otosclerosis were included 13 grade 0, 77 grade 1, 3 grade 2a, 20 grade 2b, 14 grade 2c versus 2b, and one case of 2a versus 2c.

CONCLUSION
Almost 9% of 997 retroactively reviewed petrous bone CT studies had findings positive for otosclerosis in the data base of a referral hospital for hearing loss. Use of a recently proposed classification for otosclerosis based on location of involvement yielded high interobserver agreement of 96%, and may serve to better identify and characterize cases of the disease.

REFERENCES

KEY WORDS: Otosclerosis, otospongiosis
**Temporal Bone Fractures and Traumatic Complications**

Lee, H. · Petscavage, J. · Bhatti, W.
New Jersey Medical School/University of Medicine & Dentistry of New Jersey
Newark, NJ

**Purpose**
Temporal bone fractures occur in approximately 2% of patients sustaining head trauma. Knowledge of temporal bone anatomy is essential to evaluate complications and long-term sequelae associated with the different fracture types. The purpose of our presentation is to review the CT anatomy of the temporal bone, and to demonstrate the classification of traumatic temporal bone fractures with cases of the associated vascular and neurologic complications as demonstrated by high-resolution CT.

**Materials & Methods**
A total of 2010 cases of head trauma in the emergency room from January 2006-November 2007 were reviewed retrospectively. In 40 cases of head trauma with high clinical suspicion, a dedicated CT of the temporal bones in 0.625mm slice thickness was performed with sagittal and coronal reformations. All CT scans were reviewed by one of three experienced neuroradiologists. Temporal bone fractures were classified as longitudinal, transverse, and mixed. The mechanism of the trauma was analyzed and the complications were identified. Vascular complications were diagnosed on CT angiogram of the head.

**Results**
Sixty percent (24 patients) had a temporal bone fracture. Forty-six percent (11) were longitudinal, 17% (4) transverse, and 37% (9) were mixed. Motor vehicle accidents were the most common cause of fracture, followed by assaults and falls. Seventy-one percent of those 24 patients with fractures were found to have complications. Complications included transverse and sigmoid sinus thrombosis, transverse sinus stenosis, jugular venous thrombosis, ossicular disruption, facial nerve palsy, pneumocephalus, epidural hematoma, TMJ disruption, tegmen tympani involvement, and carotid canal involvement.

**Conclusion**
Although temporal bone fractures occur in approximately 2% of patients with head trauma, high-resolution CT is recommended to define fracture plane and potential complications. Unexplained mastoid air cell opacification or pneumocephalus on CT scan of the head are the secondary signs for temporal bone fracture. Knowing the type of fracture and the complications may alter the patient management in head trauma.

**Key Words:** Temporal bone fracture, fracture with complications, head trauma

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**Characterization of Pediatric Head and Neck Masses with Diffusion-Weighted MR Imaging**

Abdel Razek, A. A. · Gabala, G. · Elhawery, G. · Megahed, A. · Nada, N.
Mansoura Faculty of Medicine
Mansoura, EGYPT

**Purpose**
To assess the clinical usefulness of diffusion-weighted MR imaging in characterization of pediatric head and neck mass.

**Materials & Methods**
This study included 78 pediatric patients (46 boys and 32 girls aged 3 months-15 years: mean 6 years) with head and neck mass. Routine MR imaging and diffusion-weighted MR imaging were done on a 1.5 T MR unit using single-shot echo-planar imaging (EPI) with a diffusion-weighted factor, factor b of 0,500 and 1000 sec/mm2. The apparent diffusion coefficient (ADC) map was reconstructed with calculation of ADC value of the mass.

**Results**
The mean ADC value of the malignant tumors was $0.93±0.18X 10^{-3}$ mm$^2$/sec, benign solid masses was $1.57±0.26X 10^{-3}$ mm$^2$/sec and of cystic lesions was $2.01±0.21X 10^{-3}$ mm$^2$/sec. The difference in ADC value between the malignant tumors and benign lesions was statistically significant ($p<0.001$). There was significant difference within malignant tumors ($P<0.001$) and benign lesions (0.001) and insignificant difference within cystic lesions ($P<0.57$). When ADC value of $1.25 X 10^{-3}$ mm$^2$/sec was used as a threshold value for differentiating malignant from benign head and neck mass, the best results were obtained with an accuracy of 92.8%, sensitivity of 94.4%, specificity of 91.2%, positive predictive value of 91% and negative predictive value of 94.2%.

**Conclusion**
Diffusion-weighted MR imaging is a new promising imaging approach that used for characterization of pediatric head and neck mass can help in differentiating malignant tumor from benign lesions. So, diffusion-weighted MR imaging can be added to routine MR imaging of pediatric head and neck mass.

**Key Words:** Diffusion, pediatric, head and neck

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**Diffuse Lipogranulomatosis Involving Soft Tissues of Head and Neck Due to Multiple Self-Injections of Mineral Oil**

Kathuria, S. · Mangla, R. · Westesson, P.
University of Rochester Medical Center
Rochester, NY

**Purpose**
To present the interesting clinical history and imaging findings of diffuse lipogranulomatosis involving soft tissues of head and neck in a 45-year-old diabetic African-American male with history of HIV and schizophrenia.
CASE REPORT
A 45-year-old African-American male with history of HIV, diabetes, and schizophrenia presented with gradually progressive diffuse swelling in the neck over 6 months. On further questioning, the history of multiple self-injections of mineral oil in the neck was provided. The initial provisional diagnosis of lipogranulomatosis based on clinical history and imaging findings was made.

IMAGING FINDINGS
CT images through the neck showed characteristic diffuse infiltrative process in bilateral soft tissues involving muscles and subcutaneous tissue. Skin biopsy showed multinucleated giant cells and inflammatory infiltrates of histiocytes and lymphocytes that have a particular tropism for connective and adipose tissue confirming the diagnosis of lipogranulomatosis due to mineral oil injections.

SUMMARY
Lipogranulomatosis following mineral oil injection, albeit rare, exhibits fairly distinct and recognizable imaging findings. Although more commonly reported in breast, scrotum and abdomen, it also can involve head and neck region. This case also illustrates the tendency of patients to conceal the history of self-injection of foreign bodies from their doctors.

KEY WORDS: Lipogranulomatosis, mineral oil injection

Monday Morning
10:45 AM – 12:15 PM
Room 204/205

(5) ELC Workshop A: Introduction to PowerPoint

Monday Afternoon
1:30 PM – 3:30 PM
Room 208/209

(6) ASPNR Programming: The Neurogenetics of White Matter Disorders

(64) Primer in Genetics
— Jennifer Northrop, MD, PhD

(65) Embryology/Histopathology of White Matter Development and Disorders
— Meenakshi B. Bhattacharjee, MD

(66) Imaging Acute Metabolic Encephalopathy of the Newborn
— Susan I. Blaser, MD

Moderator: Jill V. Hunter, MD

Primer in Genetics
Jennifer Northrop, MD, PhD

PRESENTATION SUMMARY
The field of genetics is rapidly advancing with the advent of new technologies and expanded computer capabilities that are capable of processing greater amounts of data in ever shorter periods of time. Genetics has evolved to include not only dysmorphology - a study of structure, metabolic genet-
ics - the analysis of molecular function, but has been able increasingly to identifying the individual’s unique genetic mutation by targeted sequence analysis. In the postgenome era, genetics now is evolving to include the ability to use large microarray analysis to identify an individual’s genetic fingerprint to determine disease susceptibility and predict response to different therapies. Several of these different microarrays already are being used clinically and others are currently under transition from research to clinical applications. The need for interdisciplinary communication has become increasingly important as biomarkers ascertained from both neuroradiographic and genetics studies are being used to evaluate an individual’s health status. The goal of this session is to provide a solid basis of genetics for the subsequent talks on genetics and pediatric neurologic disease. This will include both a brief review of some of the basic genetics concepts and introduce some of the newer technologies that are becoming important diagnostic tools. Special emphasis will be placed on the integration of genetic and neuroradiographic biomarkers. A genetic lexicon will be provided in addition to several resources for future reference.

Embryology/Histopathology of White Matter Development and Disorders

Meenakshi B. Bhattacharjee, MD

The most common white matter (WM) neuropathology seen in pediatric autopsies is that associated with hypoxia and/or ischemia. The marked variability of the lesions associated with these two pathologic processes, poses a challenge to the pathologist in distinguishing them from the rare heritable disorders with which they overlap morphologically. Also, unlike the relatively static reactions of mature brains to acquired injury, fetal/neonatal pathologic reactions must be considered in the context of: a) the rapid growth and plasticity of the immature nervous system, and b) the major changes in cell and tissue properties that occur during development. These differences, in part, account for the great diversity of the morphologic changes associated with hypoxic-ischemic injury (HII). Current knowledge of embryology and developmental physiology allows assignment of a tentative chronology to individual lesions, but this remains relatively inexact and must be interpreted with great caution in forensic cases. Acute WM lesions consist of WM necrosis (WMN). White matter necrosis a.k.a. periventricular leukomalacia (PVL) consists of focal, or more extensive coagulative necrosis in the immature cerebral hemispheric WM. White matter necrosis affects ~5% of all hospital births, and as many as a third of low birth weight neonates. Associated conditions include respiratory distress syndrome in premature infants, congenital heart disease in term infants, sepsis, shock, intrauterine growth retardation with hypoglycemia, and meningitis. The lesions of WMN are well demonstrated by head ultrasound scanning. The principal theory for the pathogenesis is that WMN results from impaired perfusion at the boundary zone between ventricular and ventriculofugal arteries where the metabolic requirements of the myelinating white matter are high. Other putative theories of WMN are that it results from neonatal sepsis and endotoxemia, increased anaerobic gyycolysis, accumulation of lactate and free radicals. The initial manifestations of WMN are relatively nonspecific, but most survivors later develop spastic motor dysfunction. Other pattern of WM damage include subcortical leukomalacia and telencephalic leukoencephalopathy. The latter is being recognized increasingly as the major pattern of WM damage in more recent series of perinatal HII. It is characterized by diffuse depletion of myelination glia, astrocytic proliferation and hypertrophy, and karyorrhectic glial nuclei. The long-term consequence(s) of telencephalic leukoencephalopathy are less well characterized - there is diffuse volume loss (hypoplasia) of the cerebral WM. The neurocognitive and developmental effects of this pattern of WM injury need careful longitudinal studies of large cohorts for meaningful clinico-pathologic correlation. Inherited metabolic disorders that primarily affect the WM are occasionally seen in children, and more rarely in adults. There is a wide range of clinical and morphologic appearances resulting from various genetic and biochemical defects that interfere with myelin synthesis, maintenance, turnover, and catabolism. Some conditions, particularly those associated with peroxisomal and lysosomal defects are reasonably well understood to allow for diagnosis in life. Many, however, only are diagnosed definitively at autopsy. The main criteria for the diagnosis of these disorders is the demonstration of a primary involvement of myelin (the disease process may involve some axonal loss, but there is relative axonal preservation). An etiologic classification of the leukodystrophies includes lysosomal, peroxisomal, myelin structural protein, amino-acidopathy, DNA repair, astrocytopathy, and "others". Both demyelination (loss of normal myelin), and dysmyelination (formation of abnormal myelin) may be seen.

Imaging Acute Metabolic Encephalopathy of the Newborn

Susan I. Blaser, MD

Upon completion of the presentation, participants will be able to:
1) Recognize the appearance of the more common of the inborn errors of metabolism with acute neonatal presentation.
2) Apply knowledge to differentiate between imaging appearance of inborn errors affecting the brain and hypoxic insult of the newborn.

Learning Objectives

Inborn errors of metabolism are disorders in which an enzymatic deficiency leads to a clinically significant block in a given metabolic pathway with either deficiency of a necessary metabolite or resultant accumulation of damaging substrate within a cell. Severe enzyme deficiency is associated with an early presentation. Onset of inborn errors of metabolism in the very young infant is often catastrophic with vomiting, seizures, cerebral edema and lethargy progressing to obtundation, apnea or death. Common complications of the metabolic disorders presenting in infancy include hypoglycemia, asphyxia or asphyxia-like findings (mitochondrial, molybdenum cofactor deficiency), hemorrhage (impaired
The nasopharynx is the uppermost part of the upper aerodigestive tract. It has complex anatomy and complex bound-

**Monday Afternoon**

1:30 PM – 3:30 PM

**La Louisiane Ballroom**

(7) ASHNR Programming: Neoplastic Diseases in the Head and Neck

Self-Assessment Module (SAM)+**

Audience Response Plus+(AR+)*

— Nancy J. Fischbein, MD

— Laurie A. Loevner, MD

— Caroline D. Robson, MD, ChB

**Moderator:** —  Laurie A. Loevner, MD

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

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

Nasopharynx: Anatomy and Patterns of Cancer Spread

— Nancy J. Fischbein, MD

**LEARNING OBJECTIVES**

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

1) Review anatomy of nasopharynx
2) Introduce imaging relevant to nasopharyngeal carcinoma.
3) Review patterns of spread of nasopharyngeal carcinoma.

**PRESENTATION SUMMARY**

The nasopharynx is the uppermost part of the upper aerodigestive tract. It has complex anatomy and complex bound-

**REFERENCES**


aries. These boundaries will be reviewed in our session. The nasopharynx is also in close proximity to multiple important skull base structures and foramina, and these must be carefully assessed for tumor involvement when patients have tumors of the nasopharynx. Nasopharyngeal tumors may extend to the pterygopalatine fossa (PPF), and from there they may access multiple regions by direct or perineural extension. The connections of the PPF include the palate foramina to the palate inferiorly, the sphenopalatine foramen to the nasal cavity medially, the pterygomaxillary fissure to the infratemporal fossa laterally, the vidian canal toward the infratemporal fossa laterally, the vidian canal toward the orbital fissure from the upper PPF to the orbit superiorly. Nasopharyngeal tumors may also extend to foramen lacerum (just inferior to the internal carotid artery) superiorly, and to foramen ovale superolaterally. To some degree, the tough pharyngobasilar fascia limits extension to foramen ovale. The nasopharynx is part of the Pharyngeal Mucosal Space (PMS), and as such its contents include squamous epithelium, lymphoid tissue, minor salivary glands, and pharyngeal constrictor muscles. The most common neoplastic pathologies of this space arise from these tissues, and we will focus on nasopharyngeal carcinoma (NPC). NPC is a unique malignant epithelial carcinoma of the head-and-neck region. It has an intimate association with the Epstein-Barr virus (EBV). NPC has an interesting geographic distribution whereby endemic regions such as Southeast Asia and the Mediterranean basin, the annual incidence is up to 20-30 per 100,000 people. The World Health Organization classifies NPC into 3 histological subtypes: type III is the undifferentiated carcinoma associated with EBV and most prevalent, type II is non-keratinizing squamous cell carcinoma, and type I is keratinizing squamous cell carcinoma. A variety of clinical presentations are associated with NPC. Most common is a neck mass (present in 70 to 90% of cases), followed by nasal obstruction or bleeding, hearing loss/otitis/otalgia, headache, and/or cranial neuropathy. NPC is typically treated with external beam radiation therapy. Chemotherapy is typically added for treatment of all but the earliest stages of the disease. Despite the advances made in treatment, the 5-year overall survival rate of ~75% underscores opportunities for improvement, particularly for patients with advanced disease when survival rates decline to ~60. Late radiation toxicity is also an issue. Surgery has a limited role in the management of NPC patients. Imaging plays an important role in all aspects of diagnosis, staging, treatment planning and follow-up of patients with NPC. MR is the imaging study of choice, as CT does not give adequate information regarding skull base and intracranial extent of disease. MR for assessment of nasopharyngeal carcinoma should include 3 planes of pre-gadolinium T1-weighted images, an axial or coronal T2-weighted (STIR or FSE T2) image with fat saturation, and at least 2 planes, usually axial and coronal, of post-gadolinium T1-weighted images with fat saturation. MR imaging should include the neck to at least the sternal notch in order to adequately stage lymph node involvement. Distant metastases are currently assessed most commonly with FDG PET/CT scans. PET/CT is useful not only for initial staging of disease, but also increasingly for treatment planning, and certainly for assessment of residual/recurrent disease of the nasopharynx following therapy, as well as ongoing assessment for the development of distant metastases. We will review the staging of NPC and will look at imaging examples of each stage.

**The Larynx: Anatomy and Patterns of Cancer Spread**

**Laurie A. Loevner, MD**

**Learning Objectives**

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

1. Review the anatomy of the supraglottic, glottic, and subglottic larynx with attention to important surgical landmarks.
2. Identify the roles of CT and MR imaging in evaluating the larynx, in particular in the setting of head and neck cancer.
3. Review the important radiology findings that affect patient management that should be communicated in the radiology reports to the referring clinicians.

**Presentation Summary**

The larynx is comprised of three subdivisions including the supraglottic, the glottic, and the subglottic regions. The supraglottis is comprised of the epiglottis, the aryepiglottic folds, the false vocal cords, and the arytenoid cartilage. The glottic region includes the true vocal cords, the vocal ligament which extends from the arytenoid cartilage, as well as the anterior and posterior commissures. The epiglottis extends from the level of the mid-laryngeal ventricle to 1 cm below the apex of the laryngeal ventricle. The subglottic region extends from this lower border of the glottis to the inferior aspect of the cricoid cartilage. Lesions arising below the cricoid cartilage are considered to be tracheal in nature. The larynx is secured on a osseous and cartilaginous frame work which includes the hyoid bone, the epiglottis, the thyroid cartilage, the cricoid cartilage, and the arytenoids. The complete ring of the cricoid cartilage is the only one of these cartilages that is required for the preservation of airway patency. The epiglottis protects the airway during swallowing and the vocal ligament provides support for the true vocal cord. There are several markers to identify the level of the true vocal cords. The lower cricoarytenoid joint identifies the level of the true vocal cords. In addition, while the level of the false vocal cord contains fat, at the level of the true vocal cords no fat is present and this is compromised predominantly of the thyroarytenoid muscle. The cricoarytenoid muscle moves the arytenoids allowing for glottic speech. The larynx is innervated by the vagus nerve, specifically the recurrent and the superior laryngeal nerves. The superior laryngeal nerve innervates the cricothyroid muscle. The course of the vagus and recurrent laryngeal nerve is important to understand in patients who present with vocal cord paralysis. The vagus nerve descends through the jugular foramen into the carotid sheath. The vagus nerve follows the carotid sheath inferiorly, and the recurrent laryngeal nerves loop around the aortic arch on the left and the subclavian artery on the right before ascending in the tracheoesophageal groove. Therefore, when evaluating patients with vocal cord paralysis, it is important to image throughout the level of the aortic arch or subclavian artery on the left and the right, respectively. The lymphatics of the supraglottis are abundant whereas at the glottis level they are sparse. The larynx is bordered by the pre-epiglottic space and the paraglottic space at the supraglottic level and by the paraglottic space at the glottic level. There is confusion in the literature regarding the anatomical boundaries of these regions. The pre-epiglottic space is triangular in configuration and its contents include predominantly adipose tissue and collagen fibers as well as fibrous tissue. Within the pre-epiglottic fat lymphatics may
be found; however, no lymph nodes are located within this space. The pre-epiglottic space is bounded superiorly by the hyoepiglottic ligament, inferiorly by the conus elasticus, posteriorly by the epiglottis and quadrangular membrane, and anteriorly by the thyroid cartilage and the thyrohyoid membrane. The paraglottic space contains fat, lymphatics, and small muscles. It is medial to the thyroid lamina throughout its craniocaudal extent. The pre-epiglottic and paraglottic spaces are not delineated clearly at the postero-superior aspect of the larynx; however, postero-inferiorly the pre-epiglottic and paraglottic spaces are distinct anatomically, separated by a thin membrane composed of fibrous tissue. **Larynx: Head and Neck Cancer**

The major role of CT and magnetic resonance imaging of the larynx is in evaluating tumor extent. The American Cancer Society estimated that squamous cell carcinoma of the head and neck affected over 55,000 new patients last year. Its treatment is complex, and the need for and type of surgery is guided by the site of origin of the primary tumor as well as staging at the time of clinical presentation. Staging is determined by several factors: 1) submucosal tumor spread into the deep spaces of the neck including the preepiglottic, paraglottic, and prevertebral spaces; 2) invasion of the cartilaginous framework which supports the larynx; 3) lymphadenopathy and 4) distant metastases. The best chance for cure is aggressive treatment at initial presentation based on accurate clinical staging. When possible, radiation therapy and/or surgery conserving surgery is desired. Radiation is an excellent treatment modality, but must be used with careful consideration, in particular in young patients, who have a significant risk of a second primary cancer of the aerodigestive tract (15-20%) during their lifetime. Recurrent cancers are difficult to treat and have a poor prognosis. When the maximum radiation dose allowed has been given, future therapeutic options are limited in patients with second primary carcinomas or recurrent cancers of the neck. Direct visualization combined with endoscopy are very sensitive in evaluating the mucosa of the aerodigestive tract. However, even extensive neoplastic infiltration of the deep spaces surrounding the larynx is often difficult to detect on physical and endoscopic examination. As a result, patients often are clinically understaged. Radiologic imaging has played an increasingly important role in the staging of head and neck cancer including the detection of clinically occult lymphadenopathy, cartilage invasion, as well as tumor spread into the submucosal spaces of the neck. When there is neoplastic infiltration of the preepiglottic space in patients with oropharyngeal (base of tongue) and supraglottic laryngeal tumors, supraglottic laryngectomy is frequently necessary. Extension of tumor into the paraglottic space has a high incidence of transglottic neoplastic extension, frequently requiring a total laryngectomy. In addition, neoplastic invasion of the pre-epiglottic space may be associated with increased lymphatic spread and its radiologic detection may therefore play an important role in identifying those patients at high risk for cervical lymph node metastases, especially those with microscopic disease (normal sized lymph nodes on physical and radiologic examination). These patients may benefit in addition from bilateral cervical lymphadenectomies at the time of surgery/laryngectomy. As alluded to above, staging of supraglottic carcinomas affect management. T1 and T2 tumors are limited to one subsite or greater than one subsite of the supraglottis, respectively. Both of these stages are associated with normal vocal cord mobility. Stage T3 includes those tumors limited to the larynx but with vocal cord fixation and/or invasion of the pre-epiglottic fat, medial piriform sinus, or posteriorly area. When a tumor invades the thyroid cartilage or extends beyond the larynx, it is staged as T4. In the staging of glottic cancer, T1 tumors are limited to the true vocal cords but may involve the commissures with normal mobility. Stage T2 extends to the supraglottis or subglottis and/or has impaired vocal cord mobility. Stage T1 or T2 may be treated with radiation therapy only and/or surgery depending on the extent of tumor in the cord. Stage T3 lesions are limited to the larynx with vocal cord fixation and stage T4 lesions invade the thyroid cartilage and/or extend to tissues beyond the larynx. Subglottic squamous cell carcinomas comprise less than 5% of all primary laryngeal cancers. The staging of subglottic carcinomas is similar to that of the supraglottis and glottis, based upon cord mobility, cartilaginous invasion, and extension into the soft tissues of the neck. **Other Lesions of the Larynx**

Most congenital lesions present in the neonate. Subglottic narrowing may be seen with hemangiomas or idiopathic subglottic stenosis. Laryngomalacia may also present in the neonate. All of these conditions may be self limited, resolving with supportive care. Laryngitis and epiglottitis are the major inflammatory conditions of the larynx. Laryngitis may be present at any age while epiglottitis typically occurs in children between the ages of 2 and 4 years old. Laryngitis usually is associated with viral infections, while epiglottitis usually is associated with a bacterial infection (Haemophilus Influenzae). Croup is a viral infection that occurs in the pediatric population, usually before the age of 2. It is caused by a viral infection and results in subglottic narrowing. A laryngocele is caused by obstruction of the superior saccule of the laryngeal ventricle. The saccule extends supero-laterally into the paraglottic space. The laryngeal ventricle contains air and is located between the false and true vocal cords. Hence, a laryngocele may be filled with either air or fluid. Laryngoceles are seen most commonly in people with chronic increased intraglottic pressure such as those playing wind instruments. Laryngoceles are defined as internal in nature (confined by the thyrohyoid membrane), external (the laryngocele protrudes through the thyrohyoid membrane), or mixed. Most lesions are in fact mixed. Other than malignant disease, occasional benign tumors may be seen in the larynx. These include laryngeal papilloma, polyps, hemangiomas, neurofibromas, and osseous or cartilage derived lesions (i.e., chondroid tumors). Again, discussion of neoplastic disease predominantly centers around the treatment of squamous cell carcinoma as other malignancies including lymphoma, sarcomas, and minor salivary gland cancers are relatively rare in the larynx.

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**Head and Neck Neoplasms in Children**

Caroline D. Robson, MD, ChB

**LEARNING OBJECTIVES**

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

1. Recognize the most commonly encountered head and neck tumors in children.
2. Identify with other organ system abnormalities associated with some of these tumors.
3) Analyze fetal neck masses and differentiate between the most common fetal masses.

**PRESENTATION SUMMARY**

The characteristic imaging appearance for a variety of common and/or important head and neck tumors will be reviewed in this talk. These include a) benign neck masses: hemangioma, teratoma, nerve sheath tumor, juvenile nasopharyngeal angiofibroma and b) malignant neck masses such as rhabdomyosarcoma, lymphoma and retinoblastoma. The differential diagnosis for each example will be illustrated and discussed. Where relevant, common predisposing genetic disorders will be mentioned and in some instances fetal imaging will also be demonstrated. This abstract will focus on tumors of the head and neck that occur more typically in children.

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**Monday Afternoon**

**1:30 PM – 3:30 PM**

**Room 206/207**

(8) Use of Imaging as Biomarkers and Surrogates for Assessment of New Treatments

(70) Uses of Imaging

—in Daniel Sullivan, MD

(71) New Neuroimaging Techniques and their Role in Assessment of New Therapies for Brain Neoplasms

—in A. Gregory Sorensen, MD

Moderator: A. Gregory Sorensen, MD

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**Uses of Imaging**

Daniel Sullivan, MD

**LEARNING OBJECTIVES**

Upon completion of this presentation, participants will be able to:
1) Describe the different roles that imaging biomarkers play in clinical trials.
2) Identify the standardization and quantification activities that are underway to validate imaging biomarkers.

**PRESENTATION SUMMARY**

Although several new oncology drugs have reached the market over the past few years, more than 80% of drugs for all indications entering clinical development do not get market approval. There is a need for faster, more cost-effective strategies for evaluating oncology drugs and better definition of patients who will benefit from treatment. New imaging modalities including functional imaging show high promise as the basis for characterizing better biomarkers of cancer. Imaging-based biomarkers have many potential uses in all phases of the drug development process, from target discovery and validation to pivotal clinical trials for drug registration (1). First, as disease biomarkers, imaging tests can be employed to define, stratify, and enrich study groups. These same predictive markers also can be used in many cases serially to monitor response to therapy. Second, some clinical imaging methods have potential to facilitate early clinical pharmacodynamic assessments, particularly in patients where traditionally there are no direct measures of pharmacodynamics throughout the tissues of the body and at the target. These approaches could be used in early studies comparing lead candidates designed to interact with the same target. One example is the use of dynamic contrast-enhanced magnetic resonance imaging (DCE MRI) as a measurement of the exposure-dependent effects of drugs targeting the tumor vasculature (e.g., antiangiogenesis) occurring prior to tumor shrinkage. Again, serial use of such imaging tests can be used to monitor tumor response to therapy. Third, imaging end-points can also serve as early surrogates of therapy success (2). After safety and efficacy of a new imaging agent have been demonstrated, the putative biomarker must be tested in therapeutic clinical trials to see if it actually performs as expected (i.e., to see if it predicts which patients will benefit from a particular therapy), or to see if biomarker changes correlate with response. The validity of such data depends on the imaging being done in standardized ways. Challenges to the development and implementation of imaging modalities in drug development include the lack of validation and standardization of new as well as established imaging methods. The identification and evaluation of biomarkers require access to and systematic analysis of large amounts of data, new technologies and extensive research resources. To this end, a variety of professional organizations are working to develop standards for hardware and software, for image acquisition protocols, and to transmit and process images in standard ways (3-5). Furthermore, NIH, FDA, academic researchers and industry have entered into collaborations to identify biomarkers that will be useful in drug development (e.g., the NIH Biomarker Consortium).

**REFERENCES**

New Neuroimaging Techniques and their Role in Assessment of New Therapies for Brain Neoplasms
A. Gregory Sorensen, MD


Patient-Centered Radiology
Frank J. Lexa, VII, MD, MBA

Frank J. Lexa, M.D., M.B.A. is a practicing neuroradiologist and a Clinical Professor of Radiology at the University of Pennsylvania School of Medicine. He also serves on the adjunct faculty of the Wharton School in the marketing department and has worked for programs in the Global Consulting Practicum for over a decade. This has taken him to five continents, and he is currently serving as the Asia Regional manager for the GCP. He also has an appointment as an adjunct professor of Biotechnology at the Instituto de Empresa in Madrid, Spain. Dr. Lexa lectures, consults and writes extensively on issues at the interface of health care and business science. He is the author of over 60 articles and book and encyclopedia chapters. He serves as the Director of the Executive Education Series for the American College of Radiology. Previously he directed health care investments for BTG International and worked as a strategic consultant for the Boston Consulting Group. He was a partner at Philadelphia Ventures—a venture capital firm focusing on high tech medical investments and he continues to work with start up companies in that sector. He was educated and did his medical training in Boston, the San Francisco Bay Area, and in Philadelphia. In his spare time, he bikes, flies airplanes, rides his motorcycle and chases after his two boys.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe how commoditization threatens the future of radiology.
2) Prepare for a revolution in patient expectations of radiology service.
3) Review survey data of how patient’s grade and evaluate encounters in diagnostic imaging.

PRESENTATION SUMMARY
Radiology is currently threatened on several fronts. A common fear is that diagnostic imaging services will be commoditized by a combination of rapid changes including technological innovation and globalization. Simultaneously we are living through a revolution in how patients view their relationship with the healthcare system. One way that radiology practices are adapting to this combination of threat and opportunity is to better address their customers through a more patient centered model of care delivery.
Reinventing Radiology

Fred Gaschen, MBA

Fred Gaschen has been in the health care industry for more than 30 years, the last 20 of which have been in the provision of radiological services. Joining Radiological Associates of Sacramento in 1996, Mr. Gaschen has taken RAS to its current status as the largest privately held imaging provider in the United States, serving a community of 2.2 million through 16 imaging centers, 7 Radiation Oncology Centers, 6 hospitals, 75 physicians and over 950 employees. In January 2007, readers of Medical Imaging Magazine voted RAS the top Freestanding Imaging Center company in the United States. Prior to joining RAS Mr. Gaschen held various position of increasing responsibility at Simi Valley Hospital in Simi Valley, California, Memorial Medical Center in Long Beach, Northridge Medical Center in Northridge California and Diagnostic Imaging of Southern California (DISC). Mr. Gaschen began his career as a Medical Services Corps Officer in the US Army, retiring with the rank of Lt. Colonel. Mr. Gaschen received his MBA from George Washington University, Washington, DC, and his Bachelor of Science degree in Business Administration from the University of Rhode Island, Kingston, RI. Mr. Gaschen is a frequent lecturer on radiology contracting, strategic planning, marketing, leadership, utilization, and business operations, having presented at both national and regional conferences of the ACR, AHA, RSNA, RBMA, MGMA, NMA, CRS, and AHRA, to name a few. Mr. Gaschen was voted the Auntminnie.com "Radiology Executive of the Year for 2003," and was selected as the Advance for Imaging and Oncology Administrators "2006 Administrator of the Year."

Patients of Consumers’ Medicine in the 21st Century

Andrew F. Simon, PhD, PsyD

PRESENTATION SUMMARY
Physicians are currently facing dilemmas not seen before in the practice of medicine. The abundance of (mis-)information, easily accessed through the internet and other popular sources, has placed physicians in a precarious position. Patients still turn to doctors for answers, but they now do so armed with information that may be incorrect or ill-suited for a specific individual. Additionally, economic forces are shaping patient choices and encouraging the assessment of medical treatment. Doctors now are considered to be service providers who are to be challenged when treatment is perceived as unsatisfactory. In many cases, the availability of information has empowered patients. Yet, this also has led to expectations that doctors, as service providers, should address needs of the patient that go beyond that of traditional medical training (e.g., psychologic support), or that place demands on physicians that inhibit their ability to succeed as practitioners (e.g., patients requesting a specific treatment). This presentation will utilize an integral approach to understanding the practice of radiology. Consideration will be given to the specific skills of a radiologist, as well as the psychologic needs of the patient, the cultural value system within which Western medicine functions, and the social structures that affect the doctor-patient relationship. Specifically, a focus will be on the importance of communication between doctors and patients. The integral approach will allow practitioners to more clearly understand their role within a system of healthcare. Additionally, this approach will demonstrate that facilitating the flow of accurate information between doctors and patients can allow radiologists the freedom to utilize their skills as specialists. Attending to the flow of information also will serve patient needs, leading to improved overall treatment protocols and greater patient satisfaction.
PURPOSE
In the setting of acute ischemic stroke, hypoattenuating regions on CT cerebral blood volume (CT-CBV) maps are thought to represent infarct core, tissue destined to progress to infarction. Recent case reports of CT-CBV hypodense regions that did not progress to infarction (“CT-CBV reversible lesions”) suggest that with early reperfusion, CT-CBV hypodense tissue may recover. The purpose of this study is to quantify the prevalence and extent of CT-CBV reversibility in patients who have received intraarterial (IAT) and/or intravenous (IVT) thrombolysis.

MATERIALS & METHODS
We reviewed the CT-CBV maps of acute ischemic stroke patients who received subsequent IVT and/or IAT (27 IAT and 77 IVT) between June 2004 and August 2007. We visually compared pretreatment CT-CBV maps with MR or CT follow-up images obtained a mean of 51.4 days (range 1 to 183 days) following thrombolytic therapy, to identify cases in which the follow-up infarct appeared smaller than the initial CT-CBV lesion. Vascular input function curves were checked to ensure adequate contrast response. Subsequently, initial CT-CBV maps were coregistered with follow-up studies, and CT-CBV and follow-up lesions were segmented either visually or by automatic thresholding. Lesion volumes were calculated. For follow-up studies, volume calculations were made from only those slices that covered the same region covered by the perfusion maps.

RESULTS
Six of 27 (22%) patients treated with IAT and four of 77 (5%) patients treated with IVT had CT-CBV lesions that did not progress to infarction. In the 6 IAT cases, mean initial CT-CBV lesion volume (INV) was 98.9 cm$^3$ (range 39.3 to 203.7 cm$^3$), and mean follow-up lesion volume (FUV) was 33.6 cm$^3$ (range 1.0 to 72.7 cm$^3$). Mean volume difference, defined as (FUV INV), was -65.3 cm$^3$ (range -19.1 to -131.0 cm$^3$). Mean percent decrease in lesion size, defined as (FUV INV)/INV, was -63.8% (range -23.8% to -99.2%). In the 4 IVT cases, mean INV was 190.3 cm$^3$ (range 75.0 to 240.7 cm$^3$), and mean FUV was 85.1 cm$^3$ (range 23.5 to 134.4 cm$^3$). Mean volume difference was -105.2 cm$^3$ (range -51.5 to -145.7 cm$^3$). Mean percent decrease in lesion size was -7.4% (range -39.2% to -68.7%). Figure shows an example of CT-CBV reversibility.

CONCLUSION
CT cerebral blood volume reversibility is relatively uncommon but substantial CT-CBV reversibility does occur in some patients treated with IV and/or IA thrombolytic therapy. This may have important implications for therapeutic time windows and inclusion standards in clinical trials.

KEY WORDS: CT perfusion, cerebral blood volume
Cerebral Blood Flow Thresholds for Tissue Viability in Acute Ischemic Stroke Patients Treated with Intraarterial Thrombolysis Depend on Timing of Reperfusion

Mui, K. · Yoo, A. · Verduzco, L. · Gonzalez, R. G. · Schaefer, P. W.
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Boston, MA

**Purpose**
In the setting of hyperacute ischemic stroke, DWI-PWI mismatch identifies hypoperfused but potentially salvageable brain parenchyma, the ischemic penumbra. Prior studies have demonstrated that MR perfusion relative cerebral blood flow (CBF) values can help distinguish hypoperfused penumbral tissue that will progress to infarction from that which will recover. Our purpose was to determine if MR CBF thresholds for tissue viability, in acute ischemic stroke patients treated with intraarterial recanalization therapy (IAT), depend on timing of recanalization.

**Materials & Methods**
Twenty-eight patients with acute proximal middle cerebral artery (MCA) and/or internal carotid artery (ICA) terminus occlusions underwent DWI/PWI imaging followed by IAT within 6 hours of stroke onset. Cerebral blood flow values were obtained in three regions: 1) “infarct core” with DWI hyperintensity, reduced rCBF and infarction on follow up, 2) “penumbral that infarcts” with normal DWI, reduced rCBF, and infarction on follow up, and 3) “penumbral that recovers” with normal DWI, reduced rCBF, and normal follow up. Cerebral blood flow ratios were determined for these regions by dividing the signal intensity value for each voxel of an ischemic region by the mean value of the corresponding, contralateral, uninvolved region. Cerebral angiograms were correlated visually to CBF maps and analyzed to distinguish regions that were reperfused successfully with IAT from those that were not. Cerebral blood flow ratios in tissue reperfused with IAT were compared to CBF ratios in tissue that was not reperfused with IAT. Cerebral blood flow ratios in tissue reperfused with IAT within 3.3 hours from imaging were compared to CBF ratios in tissue reperfused with IAT at greater than 3.3 hours.

**Results**
Median CBF ratios (interquartile range) for regions 1, 2 and 3 in nonreperfused tissue were 0.21 (0.12-0.37), 0.41 (0.26-0.69), and 0.48 (0.29-0.80), respectively. Median CBF ratios for regions 1, 2 and 3 in reperfused tissue were 0.15 (0.08-0.25), 0.34 (0.20-0.62) and 0.43 (0.26-0.72), respectively. Median CBF ratios for tissue reperfused at greater than 3.3 hours for regions 1, 2 and 3 were 0.19 (0.11-0.33), 0.42 (0.26-0.70), and 0.46 (0.29-0.74) respectively. Median CBF ratios for tissue reperfused at less than 3.3 hours for regions 1, 2 and 3 were 0.12 (0.06-0.25), 0.34 (0.20-0.62) and 0.43 (0.26-0.72), respectively. Median CBF ratios for regions 1, 2 and 3 in tissue reperfused within 3.3 hours were all significantly lower than their corresponding values in tissue reperfused at greater than 3.3 hours (p < 0.05).

**Conclusion**
Cerebral blood flow thresholds for tissue viability in acute ischemic stroke patients depend on timing of reperfusion. They are lower in tissue that is reperfused at earlier time points. This information may be important in selecting patients who will benefit most from thrombolytic therapy.

**Key Words:** Stroke, MR perfusion, MR diffusion

Caveats of Ischemic Penumbra in CT Perfusion: Recognition and Potential Physiologic Basis

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**Purpose**
Dynamic CT perfusion (CTP) imaging has been utilized to help evaluate suspected embolic stroke, by determination of ischemic penumbra. The University of Colorado Denver stroke program has extensively used CTP and CT angiography (CTA) for all suspected acute ischemic stroke (AIS) patients for 3 years. During this time, we have identified multiple cases of “false penumbras” and characterized possible causes.

**Materials & Methods**
Stroke alert patients were evaluated with dynamic CTP and CTA. Embolic strokes were confirmed by persistent clinical deficits and confirmatory persistent imaging findings on follow-up CT or MRI. Images were analyzed with three independent manufacturers clinical software packages capable of generating mean transit time (MTT) and/or time to peak (TTP), and cerebral blood volume (CBV) maps. False penumbras were defined as areas showing delayed MTT or TTP, in the presence of normal CBV, in a vascular territory not correlating with clinical symptoms and neurologic exam. Additionally, the false penumbras fulfilled one of the following criteria: a) area of “false penumbra” demonstrated no evidence of infarction on follow-up imaging (CT or MR) at least 48 hours post ictus; b) the artery supplying the penumbra region demonstrated no acute or subacute thrombosis on CTA and an underlying anatomical variant or chronic vasculopathy could explain the deficit; c) the patient had a clinical diagnosis of seizure or transient ischemic attack (TIA) in the contralateral vascular territory, based on clinical findings.

**Results**
CT angiographies demonstrated anatomical or pathologic findings that could explain many false penumbras. Additionally, a serendipitous study demonstrated that contrast arrival, at isolated posterior circulations, can be delayed relative to anterior circulations. These findings resulted in false penumbras that we classified into one of 6 categories: a) proximal internal carotid artery (ICA) stenosis, b) proximal ICA occlusion, c) unilateral fetal origin of posterior cerebral artery, d) single supply to both anterior cerebral arteries (absent A1 segment), e) remote infarction, f) hyperemia of contralateral hemisphere secondary to reperfusion, seizure activity or recent TIA.
Current clinical perfusion packages, with manufacturer-supplied deconvolution software, are vulnerable to false positive penumbrae. However, these limitations can be overcome by being aware of the caveats that we have defined and by analysis of concurrent CTA findings.

**Key Words:** Perfusion, CTP, penumbra

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**Purpose**
Recent studies have analyzed the prognostic value of perfusion CT (pCT) in acute stroke, and have addressed the utility of defining mismatch between irrecoverable infarct and ischemic penumbra in guiding thrombolytic therapy. Controversy exists regarding which pCT parameters best represent irreversibly infarcted tissue and ischemic penumbra. We hypothesize that in a typical patient population presenting to a tertiary care stroke center the final infarct has a minimum size corresponding to the region of cerebral blood volume (CBV) abnormality and maximum size corresponding to the region of mean transit time (MTT) abnormality. The data set indicates that these parameters can be defined easily by both the Alberta Stroke Program Early CT Score (ASPECTS) and volumetric analysis.

**Materials & Methods**
One hundred seventy-one patients presenting to the Kingston General Hospital and receiving pCT imaging between January 1999 and July 2003 were identified retrospectively. Sixty-one of these patients met the inclusion criteria of presenting with symptoms compatible with acute stroke, undergoing acute CT perfusion imaging, and follow-up conventional noncontrast CT imaging within 24-96 hours. Patients with vertebro-basilar ischemia were excluded. Dynamic pCT images were acquired immediately after the initial conventional CT and before any thrombolytic treatment. Four adjacent slices of 5 mm thickness were acquired. Follow-up conventional CT scans were used to assess ultimate infarct size. The extent of stroke size was assessed independently by two neuroradiologists (S.S. and I.O.). Stroke size on perfusion images was quantified by the two largest dimensions, ASPECTS, and percent of MCA territory involved. Stroke size on conventional CT scans was quantified by the three largest orthogonal dimensions, ASPECTS, and percent of MCA territory involved. Admission NIHHS scores were recorded by the attending neurology service.

**Results**
The minimum infarct size was consistent with the CBV abnormality, and maximum infarct size with the MTT abnormality on presentation pCT imaging. Quantification of pCT abnormality using ASPECTS yielded equivalent results as quantified by volumetric analysis.

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**Conclusion**
Mismatch between CBV and MTT pCT abnormalities in acute stroke may be used to delineate infarcted and ischemic tissue respectively, thereby identifying the penumbra. These abnormalities may be rapidly and accurately quantified by applying the ASPECT score to pCT, and may serve as a guide for thrombolytic therapy.

**Key Words:** CT perfusion, stroke, ASPECTS

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**Purpose**
Dynamic susceptibility contrast MR (DSC MR) is an important alternative to positron emission tomography (PET) for measuring cerebral blood flow (CBF) in patients with clinically significant cerebral hemodynamic impairment. Deconvolution methods that use a single, global arterial input function (AIF) can produce inaccurate estimates of CBF, especially in high-flow regions of the brain such as the gray cortical ribbon and the basal ganglia. Using localized arterial input functions (LAIF) can reduce the deleterious effects of delay and dispersion of the bolus of intravascular contrast agent. With additional use of Bayesian probability theory, we have obtained quantitative CBF measurements by DSC MR for a wide range of patients with hemodynamic impairment. In particular, this was achieved without rescaling measurements with healthy-appearing white-matter regions from the same patient.

**Materials & Methods**
Tracer kinetic perfusion models describe the concentration over time of gadolinium contrast agent administered intravenously. This concentration-time curve obeys the product of the voxel-specific CBF and the convolution of a tissue residue function with an AIF. For the method of LAIF, AIFs were determined voxel-by-voxel using a gamma-variate model, Bayesian probability theory and simulated annealing with Markov-chain Monte Carlo and Metropolis-Hastings sampling. For comparison, all patient data also were analyzed with a single, global AIF per patient and deconvolution with maximum-likelihood expectation maximization (MLEM). Both LAIF and MLEM results subsequently were compared to gold-standard CBF estimates from $H_2[^{15}O]$ PET. Positron emission tomography values were corrected for the restricted permeability of water in brain parenchyma using the butanol-based model of Herscovitch. The cohort of patients with chronic carotid occlusive disease and hemodynamic impairment were scanned as part of the St. Louis Carotid Occlusion Study. Perfusion measurements were performed in 14 patients using both $H_2[^{15}O]$ PET and DSC MR on the same day.

**Results**
In our patient cohort, Pearson product-moment correlations
for LAIF CBF versus PET CBF were 0.627. Corresponding correlations for MLEM CBF, with a global AIF, versus PET CBF were 0.321. After rescaling MLEM CBF with healthy-appearing white-matter regions, the correlations for MLEM CBF, with a single AIF, versus PET were 0.468. An analysis of alternative CBF measurements as prescribed by Bland and Altman showed the method of LAIF to agree with PET with a 95% confidence interval (CI) of ± 21.35 mL/min/100 g tissue. For MLEM deconvolution, the 95% CI was ± 50.75 mL/min/100 g, which improved to ± 32.42 mL/min/100 g after rescaling with healthy-appearing white matter.

**CONCLUSION**

Using LAIF with Bayesian probability theory made possible quantitative regional CBF maps by DSC MR. No rescaling with respect to white matter reference regions from the same patient were needed. Comparisons against CBF measurements from H₂¹⁸O PET with butanol corrections showed LAIF CBF to be robust over a wide range of clinically significant cerebral hemodynamic impairment. However, the effects of variations in pulse sequences and scanner hardware remain to be investigated.

**KEY WORDS:** Perfusion, CBF, AIF

**Paper 83 Starting at 4:10 PM, Ending at 4:18 PM**

**CT Derived Permeability Predicts Hemorrhagic Transformation in Acute Stroke**


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**PURPOSE**

To determine the ability of CT derived permeability measurement to predict hemorrhagic transformation in acute stroke.

**MATERIALS & METHODS**

Participants provided informed consent. The study was institutional review board approved. Forty-one patients presenting with acute stroke within 3 hours were recruited into this prospective single center study and underwent an acute CT protocol comprising a two-phase perfusion component enabling permeability surface product (PS) calculation. Patients were dichotomized according to hemorrhage compared to ischemic regions in nonhemorrhage patients (2.24 ± 2.37 µl/min/100g; p < 0.0001 each). PS independently predicted hemorrhage in stepwise multivariate analysis (OR 2.2; 95% CI 1.4-3.5; p = 0.001). The AUC for PS >7.7 µl/min/100g was 0.95. Sensitivity, specificity, positive and negative predictive value was 78.6%, 100%, 100% and 82% respectively.

**CONCLUSION**

PS appears promising in the prediction of hemorrhagic transformation of ischemic stroke.

**KEY WORDS:** Hemorrhagic transformation, stroke, permeability

**Paper 84 Starting at 4:18 PM, Ending at 4:26 PM**

**Prediction of Hemorrhagic Transformation in Acute Ischemic Stroke Using Abnormalities in the Recirculation Phase of Contrast Agent Bolus Passage**

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**PURPOSE**

Recombinant tissue plasminogen activator (rtPA) is an effective therapy for acute ischemic stroke (AIS), but increased risk of hemorrhagic transformation (HT) limits the general use of it (1). Advances in physiologic MR imaging have the potential to objectively guide rtPA treatment and thereby substantially reducing the risk of HT. One example is permeability MRI, which previously demonstrated to be an effective method for the assessment of blood-brain barrier (BBB) disruptions, as well as prediction of HT (2). However, one major limitation is the long scan time (~5 min). On the other hand, T2*-weighted perfusion MRI is part of the routine stroke imaging protocol and can be acquired in less than 2 minutes. From this, it is possible to extract a parameter called relative recirculation (rR) (3). The purpose of this study was to determine the relative efficacy of rR for prediction of HT in AIS patients.

**MATERIALS & METHODS**

Thirty-two AIS patients (aged 38-80 years) were examined < 4 hours of symptom onset. Relative recirculation was obtained from a T2*-weighted single-shot EPI scan. Total acquisition time for 25-40 dynamics was 1.5 minutes. Gd-DTPA (0.1mmol/kg) was injected as a bolus after a series of baseline acquisitions. Relative recirculation was calculated as previously described by Kassner et al. (3). Two regions of interests (ROI) were defined on the DWI images and then copied to the perfusion images. Mean values for rR were recorded for all patients who were grouped based on whether they received rtPA, and whether they experienced HT. A paired t-test compared mean rR values between lesions and contralateral areas. The relationship between rR and HT was investigated for all patients, and both sides, using linear regression. Finally receive operating characteristic (ROC) curves were computed for predicting HT from rR.

**RESULTS**

The occurrence rate of HT for patients receiving rtPA and those without was 43% and 37%, respectively. The rR values
overall were significantly higher in the lesions (0.19 ± 0.08) compared with contralateral areas (0.10 ± 0.03, P < 0.01). For the lesions, rR values were significantly higher in patients with HT (0.25 ± 0.06) compared with patients without HT (0.14 ± 0.05, P < 0.01). Receive operating characteristic analysis indicated a threshold of 0.18 with a sensitivity of 83% and a specificity of 71%. Moreover, the rR values were higher in patients receiving rtPA therapy (0.23 ± 0.07) compared with patients not receiving rtPA (0.15 ± 0.06, P < 0.01).

CONCLUSION
The results of this study demonstrate that rR is able to predict HT in AIS patients as assessed using ROC curves. Since rR can be obtained faster and is computed easily from routinely performed T2*-weighted perfusion MRI, it has the potential to serve as a surrogate for KPS and aid with treatment decisions immediately.

REFERENCES
3. Kassner A, et al. JMRI 2000; 03-113

KEY WORDS: Stroke, perfusion, hemorrhagic transformation

Paper 85 Starting at 4:26 PM, Ending at 4:34 PM
Thin Reconstruction Unenhanced Head CT Scans Are Highly Sensitive for Detection of Cerebral Arterial Occlusion

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PURPOSE
Initial unenhanced head CT scan plays a critical role in management of a suspected stroke patient. Detection of earliest CT ischemic changes is not only critical in diagnosis of acute stroke, but also provides prognostic value in predicting potential for intracerebral hemorrhage and functional outcome before thrombolysis administration. One of the earliest CT signs of acute ischemia includes the hyperdense middle cerebral artery (HMCA) sign and the MCA “dot” sign, reflecting the presence of hyperdense intraluminal thrombus. Using conventional head CT protocol with 5-8 mm slice thickness, the specificity of the HMCA and MCA “dot” sign approaches 100%, while the sensitivity has been reported low, ranging between 5% and 41%. We believe that this sensitivity can be improved significantly using thin-slice CT scanning technique.

MATERIALS & METHODS
Utilizing multidetector CT scanners, we have the ability to reconstruct thinner slices from the already acquired data. We have reviewed retrospectively head CT scans of 59 consecutive patients suspected of having acute stroke. We then reconstructed thin 1.25 mm images from the already acquired data and the images were interpreted by two of the authors. The postprocessed interpretations then were compared to the patient’s clinical picture, follow-up CT scans, CTA, MRI, MRA and/or angiography studies for confirmation of presence or absence of intraarterial thrombus.

RESULTS
A total of 31 patients suspected of ischemic stroke underwent conventional or CT angiography. Our preliminary results demonstrated sensitivity of 91% for detection of middle cerebral artery occlusion on thin reconstructed images as compared to 36% for those acquired at 5 mm slice thickness. The specificity remained at 100%. The data correlated with a positive predictive value of 100% and negative predictive value of 95%.

CONCLUSION
Improved sensitivity of detection of dense cerebral arteries will result in improved patient management. Our preliminary data demonstrates significant increase in sensitivity for detection of middle cerebral artery occlusion using thin reconstruction. The added sensitivity will come at no additional radiation burden to the patient since images are processed retroactively. We are actively adding more cases and our completed project will include recruitment of additional interpreters of varying expertise, including a radiology resident, with further expansion of the controlled blinded study. We anticipate that the outcome of this study will result in revision of the current head CT protocol and ultimately will result in improved management of stroke patients.

KEY WORDS: Acute ischemic stroke, dense middle cerebral artery sign, CT

Paper 86 Starting at 4:34 PM, Ending at 4:42 PM
CT Perfusion Quantification of Small Vessel Ischemia

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1Sunnybrook Health Sciences Center, Toronto, ON, CANADA, 2University of Toronto, Toronto, ON, CANADA, 3University of Western Ontario, Robarts Research Institute; Lawson Health Research Institute, London, ON, CANADA, 4Queen’s University, Toronto, ON, CANADA

PURPOSE
Quantification and correlation of white matter severity with CT perfusion (CTP) is not reported previously.

MATERIALS & METHODS
Participants provided informed consent. The study was institutional review board approved. One hundred twenty patients with stroke-like symptoms underwent CTP and MRI. Thirty-five patients [15 female, 20 male; age 66 ± 15.7 years (IQR 51-80)] rapidly resolving, having normal imaging consistent with TIA constituted the study cohort. Two neurologists, blinded to clinical history independently rated MRI age-related white matter change scores (ARWMC). Patients were dichotomized apriori into mild and moderate to severe white matter groups by ARWMC. Periventricular, subcortical and average blood flow, volume, transit time and permeability were calculated. Spearman correlation with ARWMC was performed. Wilcoxon rank sum or Fisher exact test compared differences between white matter group demographic data and CTP variables. Associations with white matter disease severity was tested by uni and multivariate logistic regression analyses. ROC analysis was performed.
RESULTS
There was a significant correlation between ARWMC MRI score and ROI PV CBF (r = -0.55, p = 0.0007), ROI SC CBF (r = -0.50, p = 0.002). Univariate analysis demonstrated significant association between white matter severity and ROI PV CBF (p = 0.049), ROI SC CBF (p = 0.033) and average CBF (p=0.032). Multivariate analysis demonstrated significant association between ROI SC (p = 0.032), average ROI CBF (0.007) and white matter disease severity. Area under the curve was 0.82 and 0.84 respectively.

CONCLUSION
CT perfusion derived ROI SC and average CBF are associated independently with white matter disease severity.

KEY WORDS: White matter disease, CT perfusion

Paper 87 Starting at 4:42 PM, Ending at 4:50 PM
Crossed Cerebellar Diaschisis in Acute Stroke Detected by Dynamic Susceptibility Contrast MR Perfusion Imaging

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PURPOSE
Crossed cerebellar diaschisis (CCD), the decrease in blood flow and metabolism in the cerebellar hemisphere contralateral to a supratentorial stroke, frequently is reported on PET and SPECT but rarely described using MR perfusion techniques. This study was undertaken to determine the frequency of CCD observed in acute stroke by retrospective review of a research data base of acute stroke patients evaluated by diffusion-weighted (DWI) and dynamic contrast susceptibility perfusion MRI (PWI).

MATERIALS & METHODS
1.5 T diffusion and perfusion MR scans of 134 consecutive acute stroke patients were reviewed. The presence of contralateral cerebellar hypoperfusion was identified by inspection of TTP maps with an absence of cerebellar abnormalities on T2-weighted scans, DWI, or disease of the vertebrobasilar system on MRA. Quantitative analysis of perfusion scans was performed using an arterial input function and singular value decomposition (SVD) in order to generate cerebral blood flow (CBF) maps.

RESULTS
Four of 134 cases (2.98%) met the criteria of CCD and were well illustrated by the asymmetry of cerebellar perfusion on TTP maps (one example shown in figure). On quantitative analysis, all four cases also showed corresponding reduction of CBF ranging from 20 to 50% of the unaffected cerebellar hemisphere.

CONCLUSION
MR perfusion techniques can be used to detect CCD, although the frequency presented in this series is low compared to that in the PET/SPECT literature probably related to a number of technical issues. Nevertheless, with its role in acute stroke and noninvasive nature, MR perfusion may be a viable alternative to PET or SPECT for studying the phenomenon and clinical consequences of CCD.

KEY WORDS: Crossed cerebellar diaschisis, MR perfusion, stroke

Paper 88 Starting at 4:50 PM, Ending at 4:58 PM
Which Patient Suffering from Transient Ischemic Attack Requires Immediate Cranial CT Imaging?

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PURPOSE
A transient ischemic attack (TIA) is defined by acute onset of neurologic symptoms lasting less than 24 hours without evidence of infarction; however, these patients have an increased risk to develop a major stroke. Cranial CT (CCT) usually is performed initially to rule out other causes of this neurologic deterioration. To justify exposure to radiation by CT it should be sensitive enough to depicted the underlying causes.

MATERIALS & METHODS
We reviewed all CCT requests within 1 year of patients presenting with TIA. CT scans, emergency notes, charts and other performed imaging modalities were reviewed. Cases that turned out to be a seizure with Todd paralysis rather than a TIA and other causes that would require immediate emergency imaging (i.e., anticoagulated patients with head trauma or acute hypertensive dysregulation) were excluded.

RESULTS
From 3580 requests for a CCT, 350 (9.8%) were performed because of transient neurologic symptoms. Two hundred five of these patients (5.7%) presented with a TIA lasting less than 1 hour. Five (2.4%) had a pathologic finding. One infarction was diagnosed on CCT that turned out to be an artifact. Two infarctions were found, of which one showed already hemorrhagic transformation. We detected one metas-
tasis (lung cancer) and one meningioma. In the remaining group without pathologic findings, four infarctions were found on MRI.

**Conclusion**
Strokes can present as TIA especially when they affect clinically “silent” regions. Sixty-six percent of pathologic findings were missed on completely CCT, which is dispensable in TIA lasting less than 1 hour. Instead a sufficient cerebrovascular imaging such as MRI should be performed.

**Key Words:** Transient ischemic attack, CCT, stroke

**Paper 89 Starting at 4:58 PM, Ending at 5:03 PM**

**Arterial Spin Labeled MR Imaging in Migraine Evaluation**

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**Purpose**
We present the spectrum of perfusion abnormalities associated with migraine headache on arterial spin labeling (ASL). Migraine perfusion patterns and, specifically, hemiplegic migraine associated hyperperfusion have not been evaluated previously with the ASL technique.

**Case Report**
We performed a retrospective analysis of MRI exams including ASL perfusion imaging in 48 patients with a history of headache. Eleven patients had a specific history of migraine. Of the 11 patients, three showed migraine associated perfusion anomalies corresponding to the clinical presentation.

Case 1: A 55-year-old female with a history of hemiplegic migraines presented with new onset right frontal headache, left-sided numbness, weakness, and dysarthria. Conventional sequences demonstrated subtle sulcal effacement and mild edema in the right frontal cortex without evidence of diffusion abnormality. Arterial spin labeling images showed marked regional hyperperfusion in the right frontal and parietal cortex (Figure). Repeat MRI 6 days later demonstrated resolution of the hyperperfusion on ASL. After a complicated hospital course, the patient’s hemiplegia and other neurologic symptoms completely resolved.

Case 2: A 52-year-old female with a history of TIA and migraine headaches presented with “shaky” vision episodes lasting 30 seconds. The patient later developed a severe migraine headache during her admission requiring narcotics. CT of the head and conventional MRI and MRA sequences obtained during the headache were normal. Arterial spin labeling showed hyperperfusion in the medial occipital lobes bilaterally.

Case 3: A 37-year-old female presented with two 30-minute episodes of acute painless vision loss in the right eye preceded by bright visual sensations. Each episode of vision loss was accompanied by a dull headache. CT of the head and conventional MRI and MRA sequences were normal. Arterial spin labeling demonstrated focal hypoperfusion in the right visual cortex. The patient was treated with Verapamil for migraine prophylaxis and remained asymptomatic at 6-month follow up.

**Imaging Findings**
Migraine-associated perfusion anomalies have been described, but until now a safe, nonradioactive, non-IV contrast, easily repeatable imaging study has not been available.

**Summary**
As ASL becomes more widely implemented, its unique advantages over conventional perfusion studies give this perfusion sequence significant potential in the evaluation of the symptomatic migraine patient.

**Key Words:** Arterial spin labeling, migraine

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**Monday Afternoon**

**3:30 PM – 5:00 PM**

**Room 206/207**

(12b) ADULT BRAIN: Neoplasms I
(Scientific Papers 90 – 102)

See also Parallel Sessions
(12a) ADULT BRAIN: Cerebrovascular Occlusive Diseases
(12c) HEAD & NECK: Orbital Faces and New Techniques
(12d) PEDIATRIC: Neoplasms & New Techniques/Excerpta

Moderators: John R. Hesselink, MD, FACR
Vincent P. Mathews, MD
Multifocality in Glioblastoma Multiforme?

Ulmer, S. · Jansen, O. · Barker, F. G. · Henson, J. W.
1University Hospital of Schleswig-Holstein, Kiel, GERMANY, 2Massachusetts General Hospital, Boston, MA

Purpose
Malignant gliomas have been reported to be multifocal in 5 to 15% of cases. They are less likely to be multifocal at the time of diagnosis than are metastatic tumors, a fact that often is used to predict the etiology of newly detected mass lesions. However, the incidence of multifocality in malignant gliomas has not been well characterized using MRI.

Materials & Methods
We retrospectively reviewed preoperative MRI scans of 141 patients with enhancing, newly detected malignant glioma, and determined the incidence of multifocal lesions, which was compared to the incidence of multifocal lesions in a comparison group of 88 patients with brain metastases. The nature of the multifocal lesions also was characterized. Imaging sequences had to include a T1-weighted sequence + Gd and a T2-weighted sequence (i.e., FLAIR) before resection of the tumor. Type I lesions were single enhancing lesions. Multifocal lesions were divided into type IIa having a contiguous region of T2-weighted signal hyperintensity between the lesions of which at least one had to demonstrate contrast enhancement and type IIb having two or more completely discrete lesions.

Results
Overall 95 glioblastomas could be included in the study. Of these 65% were single lesions (type I). Multifocal lesions were present in 35% of patients with GBM. Fifty-five of 88 (58%) patients with newly diagnosed brain metastasis had multifocal lesions (difference significant at p < 0.001). Discrete enhancing foci within a region of contiguous T2-weighted hyperintensity were seen in 19% of GBM (type IIa). Entirely separate foci were present in 12% of GBM (type IIb). In metastasis the pattern of entirely separate foci was much more common (19%, type IIb) than being multifocal with a connecting T2-abnormality (2%).

Conclusion
Multifocal lesions are more common in patients with newly detected malignant glioma than is currently understood. The pattern of a contiguous T2-abnormality between lesions can distinguish GBM from metastasis.

Key Words: Glioblastoma multiforme, multifocality, MRI
most reviews of pilocytic astrocytomas describe minimal, if any, surrounding edema, we found that supratentorial lesions usually show moderate to severe edema. Pilocytic astrocytomas in adults may have a more aggressive imaging appearance, including significant vasogenic edema and mass effect that mimics a higher grade neoplasm.

**KEY WORDS:** Pilocytic astrocytoma

**Paper 92 Starting at 3:46 PM, Ending at 3:54 PM**

**Quantifying Enhancement Characteristics as a Discriminant of High- and Low-Grade Glioma**

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**PURPOSE**

Attempts have been made to quantify contrast enhancement in glioma by evaluating changes in the signal intensity following administration of contrast agent. Although simple to apply, these measures have the disadvantage of dependency upon signal intensity, which can be unreliable and poorly reproducible. Dynamic contrast-enhanced MRI (DCE MRI) allows quantification of the concentration of contrast agent over time. Initial area under the concentration curve (IAUC) quantifies contrast agent passing through tissue and is considered reliable and reproducible. Enhancing fraction can be calculated by measuring the proportion of voxels in a tumor with a measurable IAUC. Enhancing fraction does not quantify enhancement intensity, the application of thresholds of IAUC (above which a voxel is defined as enhancing) may be of value in quantifying this. Aims were to examine how enhancing fraction calculated for different IAUC thresholds varied with tumor grade and related to signal intensity measures of enhancement.

**MATERIALS & METHODS**

Thirty-two gliomas (11 grade II, 2 grade III, & 19 grade IV) were imaged on a 3.0 T Philips Achieva MR scanner, prior to surgery. Imaging included T1-weighted DCE MRI and anatomical sequences. Voxels within a tumor were identified as enhancing if the IAUC60 (the IAUC 60 seconds following the initial contrast bolus injection) was greater than various specified thresholds. Enhancing fraction was calculated for different threshold values of IAUC60. An initial (II, n = 5 and IV, n = 10) analysis was performed to identify the optimal IAUC60 threshold for grade separation (Figure). For each tumor-enhancing fraction for IAUC60>0mMol.s (EnFr), and for IAUC60>2.5mMol.s (EnFr<2.5), the initial slope of the thresholded curve, IAUC60 and signal intensity measures of enhancement were calculated.

**RESULTS**

The thresholded enhancing fraction curves demonstrated clear differences between grade II and IV (Figure). Slope (p<0.0001), IAUC60 (p<0.0001), and signal intensity measures of enhancement (p<0.0001 and p=0.009) distinguished grade II from IV. All measures, apart from slope, showed some overlap between the groups. EnFr did not distinguish between grade (p=0.960).

**CONCLUSION**

Optimizing the IAUC60 threshold used in calculating enhancing fraction distinguishes tumor grade. We have described a new measure, slope, which provides excellent discrimination between grades II and IV. While signal intensity-based measures have shown sensitivity in early prediction of malignant transformation in low grade tumors, the measure slope is based upon the IAUC60, should be reliable and reproducible, and may prove to be a more robust measure for identifying tumor dedifferentiation.

**KEY WORDS:** Glioma, grade, DCE-MRI

**Paper 93 Starting at 3:54 PM, Ending at 4:02 PM**

**Effect of Dexamethasone on Tumor Vascular Permeability and Other Perfusion Parameters in Gliomas Using CT Perfusion**

Ellika, S. K. · Jain, R. · Scarpace, L. · Schultz, L. R. · Patel, S. C. · Mikkelsen, T.

Henry Ford Health Systems Detroit, MI

**PURPOSE**

The aim of our study was to determine the effect of steroids on perfusion parameters especially permeability surface area-product (PS) in the tumor (T), in the peritumoral region (PR) and in the contralateral normal appearing white matter (NAWM) in patients with high-grade gliomas.

**MATERIALS & METHODS**

Our study included 23 patients with treatment naïve high-grade astrocytomas. There were 17 GBMs and 6 anaplastic astrocytomas. Of these 23 patients 15 patients (GBM=13 and AA=2) were on a stable dose of steroids and eight patients were not on steroids (GBM=4 and AA=4). All patients were investigated with perfusion CT before undergoing any other treatment. All perfusion scans were done on a 64-slice scanner using a total acquisition time of 170 seconds. Perfusion maps of PS, CBV, CBF and MTT were generated using the CT perfusion 3.0 software. Regions of interest (ROIs) were drawn manually within the tumor (T) taking care to avoid
areas of necrosis and also within the peritumoral region (PR) in 20 patients (peritumoral ROIs were not drawn in 3 patients as there was no peritumoral edema on imaging). Regions of interest also were drawn in the contralateral normal appearing white matter (NAWM).

**RESULTS**

Descriptive statistics for each parameter were computed for the two groups (patients on steroids and patients not on steroids). Table 1 contains the results for all patients, while Table 2 contains the results for patients with only grade IV tumors. None of the differences were statistically significant (p < 0.05). However, trends were observed for CBV (T) (p = 0.063) and CBF (T) (p = 0.066) (Table 1). Patients on steroids showed a higher tumoral CBV and CBF than patients who were not on steroids. Notably there was no statistically significant difference in PS between the steroid and nonsteroid groups. There was no statistically significant difference in the perfusion parameters between the steroid and nonsteroid group for the peritumoral region.

Table 1: Grade III and Grade IV tumors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Steroids (N=15)</th>
<th>No Steroids (N=8)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS(T)</td>
<td>2.39 ± 1.37</td>
<td>2.22 ± 1.57</td>
<td>0.789</td>
</tr>
<tr>
<td>PS(NAWM)</td>
<td>0.68 ± 0.35</td>
<td>0.59 ± 0.28</td>
<td>0.532</td>
</tr>
<tr>
<td>PS (PR)</td>
<td>0.50 ± 0.16</td>
<td>0.61 ± 0.15</td>
<td>0.181</td>
</tr>
<tr>
<td>CBV(T)</td>
<td>3.07 ± 1.12</td>
<td>2.11 ± 1.14</td>
<td>0.063</td>
</tr>
<tr>
<td>CBV(NAWM)</td>
<td>0.77 ± 0.19</td>
<td>0.80 ± 0.16</td>
<td>0.730</td>
</tr>
<tr>
<td>CBV (PR)</td>
<td>0.84 ± 0.31</td>
<td>0.93 ± 0.30</td>
<td>0.573</td>
</tr>
<tr>
<td>CBF(T)</td>
<td>98.27 ± 87.10</td>
<td>49.74 ± 29.99</td>
<td>0.066</td>
</tr>
<tr>
<td>CBF(NAWM)</td>
<td>24.78 ± 17.75</td>
<td>18.79 ± 7.10</td>
<td>0.265</td>
</tr>
<tr>
<td>CBF (PR)</td>
<td>21.22 ± 19.40</td>
<td>23.34 ± 8.87</td>
<td>0.802</td>
</tr>
<tr>
<td>MTT(T)</td>
<td>4.52 ± 1.39</td>
<td>4.87 ± 1.45</td>
<td>0.574</td>
</tr>
<tr>
<td>MTT(NAWM)</td>
<td>5.55 ± 1.84</td>
<td>4.15 ± 1.83</td>
<td>0.096</td>
</tr>
<tr>
<td>MTT (PR)</td>
<td>7.47 ± 2.48</td>
<td>5.49 ± 2.10</td>
<td>0.106</td>
</tr>
</tbody>
</table>

Table 2: Grade IV tumors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Steroids (N=13)</th>
<th>No Steroids (N=4)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS(T)</td>
<td>2.59 ± 1.34</td>
<td>3.43 ± 1.15</td>
<td>0.277</td>
</tr>
<tr>
<td>PS(NAWM)</td>
<td>0.67 ± 0.37</td>
<td>0.77 ± 0.29</td>
<td>0.656</td>
</tr>
<tr>
<td>PS (PR)</td>
<td>0.47 ± 0.13</td>
<td>0.58 ± 0.19</td>
<td>0.216</td>
</tr>
<tr>
<td>CBV(T)</td>
<td>3.12 ± 0.97</td>
<td>2.85 ± 1.05</td>
<td>0.632</td>
</tr>
<tr>
<td>CBV(NAWM)</td>
<td>0.74 ± 0.18</td>
<td>0.82 ± 0.23</td>
<td>0.458</td>
</tr>
<tr>
<td>CBV (PR)</td>
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</tr>
<tr>
<td>CBF(T)</td>
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<td>67.35 ± 34.16</td>
<td>0.437</td>
</tr>
<tr>
<td>CBF(NAWM)</td>
<td>25.02 ± 18.96</td>
<td>17.66 ± 9.68</td>
<td>0.473</td>
</tr>
<tr>
<td>CBF (PR)</td>
<td>21.20 ± 20.20</td>
<td>19.31 ± 7.74</td>
<td>0.860</td>
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<td>MTT(T)</td>
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<td>MTT(NAWM)</td>
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<tr>
<td>MTT (PR)</td>
<td>7.57 ± 2.55</td>
<td>6.40 ± 1.79</td>
<td>0.411</td>
</tr>
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</table>

**CONCLUSION**

No statistically significant difference was noted in cerebral perfusion parameters especially PS of the tumor, PR or in the NAWM in high-grade gliomas in the steroid and the nonsteroid group. There was a slight trend with increased tumoral CBV and CBF seen in the steroid group as compared to the nonsteroid group which might be related to some “normalization” of the tumor vasculature. Similarly PS grade IV gliomas on steroids showed slightly lower PS as compared to the nonsteroid group, but were not statistically significant.

**KEY WORDS:** Dexamethasone, perfusion CT, permeability

**RESULTS**

Descriptive statistics for each parameter were computed for the two groups (patients on steroids and patients not on steroids). Table 1 contains the results for all patients, while Table 2 contains the results for patients with only grade IV tumors. None of the differences were statistically significant (p < 0.05). However, trends were observed for CBV (T) (p = 0.063) and CBF (T) (p = 0.066) (Table 1). Patients on steroids showed a higher tumoral CBV and CBF than patients who were not on steroids. Notably there was no statistically significant difference in PS between the two groups. There was no statistically significant difference in the perfusion parameters between the steroid and nonsteroid group for the peritumoral region.

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CONCLUSION
Normalized rCBV and Cho/Cr measurements correlated well with histopathologic grade. Normalized rCBV measurement is more accurate than MRS measurements in differentiating glial tumor grade. Normalized rCBV was the best predictor of glioma grade, and the combination of rCBV with Cho/Cr could be the best set of metrics to predict glioma grade.

KEY WORDS: Glioma, MRI, MRS

Paper 95 Starting at 4:10 PM, Ending at 4:18 PM
Differentiation of Recurrent Intraaxial Metastatic Tumor from Delayed Radiation Effects of Gama Knife Radiosurgery Using Dynamic Susceptibility-Weighted Contrast-Enhanced Perfusion MR Imaging

Barajas, R. F. • Chang, J. S. • Sneed, P. • McDermott, M. • Cha, S.
University of California San Francisco
San Francisco, CA

PURPOSE
MRI-guided gamma knife radiosurgery often is used to treat intraaxial metastatic neoplasms. Following treatment, differentiating whether a progressively enhancing lesion is due to tumor recurrence or the effects of radiosurgery is often difficult. The purpose of our study was to determine whether relative cerebral blood volume (rCBV), relative peak height (rPH), and percentage of signal intensity recovery (PSR) derived from dynamic susceptibility-weighted contrast-enhanced (DSC) perfusion MR imaging can differentiate recurrent tumor from the delayed effects of radiosurgery.

MATERIALS & METHODS
Thirty-four cases of histologically proved recurrent tumor (n=23) and radiation effect (n=11) were studied retrospectively using anatomical and DSC perfusion MR imaging on the basis of the following criteria: previous treatment with gamma knife radiosurgery following histopathologic diagnosis of metastatic intraaxial tumor, subsequent progressive enhancement within radiation field, and follow-up MRI findings consistent with tumor recurrence. Regions of interest were drawn around contrast-enhancing region. Resulting T2*-signal intensity time curves were interrogated to produce rCBV, rPH, and PSR. Univariate analysis utilizing two sample Welch T-test was used to compare mean values between groups. P-value < 0.05 was considered statistically significant.

RESULTS
Mean time from radiosurgery to final diagnosis and mean volume of enhancement was not statistically different (P=0.9 and P=0.29). Mean initial radiation dosage was found to be similar between the two groups (17.45Gy versus 17.95Gy; p>0.05). Mean and minimum percentage of signal intensity recovery values were significantly lower (P<0.01) in cases of recurrent tumor (Table). The mean and maximum rCBV and rPH values were significantly higher in the recurrent tumor group compared to the radiation effect group (Table). A PSR cutoff value of 76.3% served as a reliable marker for differentiating between the two groups (sensitivity 95.65% and specificity of 100%).

TABLE. Relative cerebral blood volume, relative peak height, and percentage of signal intensity recovery in contrast-enhancing region.

<table>
<thead>
<tr>
<th>Final Diagnosis</th>
<th>Maximum rCBV</th>
<th>Mean rCBV</th>
<th>Minimum rCBV</th>
<th>Maximum rPH</th>
<th>Mean rPH</th>
<th>Minimum PSR</th>
<th>Mean PSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent Tumor</td>
<td>3.46 (2.19)</td>
<td>2.38 (0.95)</td>
<td>1.65 (1.32)</td>
<td>1.58 (0.55)</td>
<td>51.98 (12.76)</td>
<td>60.64 (9.95)</td>
<td></td>
</tr>
<tr>
<td>Radiation Effect</td>
<td>2.04 (1.29)</td>
<td>1.54 (0.92)</td>
<td>1.10 (1.03)</td>
<td>1.03 (0.49)</td>
<td>79.25 (8.98)</td>
<td>83.33 (3.59)</td>
<td></td>
</tr>
<tr>
<td>Welch P value</td>
<td>&lt;0.01</td>
<td>0.024</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>(95%CI)</td>
<td>(-2.95,-0.49)</td>
<td>(-1.16,0.12)</td>
<td>(-0.94,-0.16)</td>
<td>(-0.94,-0.16)</td>
<td>(20.35,34.19)</td>
<td>(17.73,27.63)</td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION
Although the relatively small sample size of this retrospective study cautious against over interpretation, our results suggest quantitative analysis of signal intensity time curves obtained from DSC perfusion MR imaging provide additional insight into tumor vasculature properties that in a clinical setting may increase the specificity of differentiating tumor recurrence from the delayed effects of gamma knife radiosurgery (Figure).

KEY WORDS: Brain, neoplasm, perfusion

Paper 96 Starting at 4:18 PM, Ending at 4:26 PM
Glioblastoma Treated with Postoperative Radio-Chemotherapy: Prognostic Value of Apparent Diffusion Coefficient at MR Imaging

Yamasaki, F. • Sugiyama, K. • Ohtaki, M. • Takeshima, Y. • Abe, N. • Akiyama, Y. • Takaba, J. • Amatya, V. J. • Saito, T. • Kajiwara, Y. • Hanaya, R. • Kurisu, K.
Hiroshima University
Hiroshima, JAPAN

PURPOSE
To retrospectively evaluate whether the mean, minimal and maximal apparent diffusion coefficient (ADC) of glioblastomas observed on pretreatment magnetic resonance (MR) images is of prognostic value in patients with glioblastoma.

Key Words: Brain, neoplasm, perfusion
**MATERIALS & METHODS**
Between February 1998 and January 2006, 33 patients (24 males, 9 females; age range, 10 - 76 years) with supratentorial glioblastoma underwent pretreatment MR imaging. The values of the mean, minimum and maximum ADC (ADC-mean, ADC-MIN and ADC-MAX, respectively) of each tumor were determined preoperatively from several regions of interest defined in tumors, preferably those without cystic, necrotic or hemorrhagic components. Surgical intervention was followed by irradiation and chemotherapy for all patients according to hospital protocol. Patient age, symptom duration, Karnofsky performance scale (KPS) score, extent of surgery and ADC were assessed using factor analysis of overall survival. Prognostic factors were evaluated using Kaplan-Meier survival curves, the logrank test and the Cox proportional hazards model.

**RESULTS**
The ADC values were distributed as follows: ADC-mean [range, (0.716 - 1.389) x 10-3 mm2/sec; mean 1.070 x 10-3 mm2/sec; median 1.066 x 10-3 mm2/sec], ADC-MIN [range, (0.676 - 1.260) x 10-3 mm2/sec; mean 0.934 x 10-3 mm2/sec; median 1.100 x 10-3 mm2/sec], ADC-MAX [range, (0.716 - 1.389) x 10-3 mm2/sec; mean 1.070 x 10-3 mm2/sec; median 1.050 x 10-3 mm2/sec]. Likelihood tests confirmed that ADC-MIN was the strongest prognostic factor among the three. Total surgical removal was the most important predictive factor for overall survival (P < 0.01, log-rank test). ADC-MIN was also statistically correlated with overall survival (P < 0.05) and could be used to classify patients into different prognostic groups. Interestingly, ADC-MIN was the strongest prognostic factor (P < 0.01) among patients for the group in which total removal of the tumors was not possible.

**CONCLUSION**
Minimum ADC at the time of pretreatment MR imaging is a useful clinical prognostic biomarker for patients with glioblastoma.

**KEY WORDS:** Apparent diffusion coefficient, echo planar imaging, glioblastoma

**Paper 97 Starting at 4:26 PM, Ending at 4:34 PM**
**MR Sodium Imaging is a Biomarker for Tumor Response to Fractionated External Beam Radiation Therapy**

Damen, F. C. · Lu, A. · Villano, J. · Aydogan, B. · Smith, B. · Flannery, M. · Ganin, H. · Halpern, H. · Atkinson, I. · Thulborn, K.

1University of Illinois at Chicago, Chicago, IL, 2University of Chicago, Chicago, IL

**PURPOSE**
Despite surgical resection, radiation and chemotherapy, patients with high-grade brain tumors show 70% local recurrence with concomitant poor survival at 2 years. Quantitative sodium MR imaging may provide an imaging biomarker, predictive of early regional tumor responses, that could be used to guide targeted radiation treatment to regions with poor initial response without over-treating responsive regions.

**RESULTS**
Figure 1 shows the temporal accumulated dose response of TSC in different voxels across the surgical bed of a glioblastoma multiforme in one patient during 6 weeks of fractionated radiation treatment. Voxels in normal brain tissue have a constant TSC of about 45mM (A). Voxels with edema but no tumor have initially high TSC and return to normal TSC values during treatment (B). Tumor with high TSC that do not change during treatment suggest nonresponsive regions that are likely to recur (C). Some of these regions are necrotic and are not expected to change. Tumor with high TSC responsive to treatment show increasing TSC (D). Regions of high TSC that do not return completely to normal TSC values are also likely to have incomplete responses with decreased cell density consistent with tumor (E). These patterns are identified clearly within 3 weeks of treatment allowing adaptive radiation therapy to be implemented immediately. In the patients being followed for recurrence, follow-up perfusion studies suggest treatment failure occurs in the regions suggested by the TSC responses.

**CONCLUSION**
Quantitative sodium imaging may predict local recurrence of tumor early during fractionated radiation treatment thereby allowing adaptive radiation treatment.

**KEY WORDS:** Sodium, radiation therapy, biomarker
Utilization of MR Perfusion in Assessment of Treatment Response of Recurrent High Grade Gliomas following Antiangiogenic Therapy

Karimi, S. • Hou, B. • D’Ambrosio, N. • Abrey, L. E. • Holodny, A. • Gutin, P. H.
Memorial Sloan-Kettering Cancer Center
New York, NY

PURPOSE
To test the hypothesis that microvascular changes related to treatment with bevacizumab can be detected reliably with MR perfusion and that vessel permeability (~Ktrans) and microvascularity (fraction blood volume: fBV or rCBV) of enhancing brain tumors decrease with treatment. We also aimed to assess which parameter is most sensitive for detecting hemodynamic changes.

MATERIALS & METHODS
DCE and DSE perfusion techniques were performed on patients with recurrent high-grade gliomas before and after the first cycle of bevacizumab. Fourteen patients (12 GBM and 2 high-grade astrocytoma) were studied. Among these patients, nine (7 GBM and 2 high-grade astrocytoma) had DCE and DSE before and after the first cycle (2 doses). Baseline perfusion imaging was performed within 2 weeks prior to the first dose. Bevacizumab was administered once every 2 weeks, on days 1 and 15 of the cycle, which was defined as 28 days. Follow-up MR perfusion were performed (25-29 days; mean 27.3 days after the first dose). The ratios of the Ktrans, fBV, rCBV and wash in slopes were calculated for ROIs in the tumors and in the contralateral hemisphere. Mean values (M) with standard deviations (SD) for the ratios pre and postcycle 1 were calculated, and a paired or unpaired T-test for the ratios were performed. A “p” less than 0.05 for a ratio was considered statistically significant.

RESULTS
Before treatment, the Ktrans, fBV and rCBV ratios for all 14 patients were high with means of 1.85 (SD = 0.80), 1.83 (SD = 0.91) and 2.4 (SD = 0.91), respectively. These values decreased in the nine patients who had DCE and DSE perfusion imaging after treatment. Table lists the mean ratios for the nine patients during the first bevacizumab cycle.

Table: Mean bolus wash-in slopes (M±SD) Ktrans (M±SD) fBV (M±SD) rCBV (M±SD)

<table>
<thead>
<tr>
<th></th>
<th>Ktrans (M±SD)</th>
<th>fBV (M±SD)</th>
<th>rCBV (M±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE</td>
<td>2.03±1.77</td>
<td>1.86±0.80</td>
<td>1.83±0.85</td>
</tr>
<tr>
<td>POST</td>
<td>0.84±0.85</td>
<td>1.26±0.21</td>
<td>1.36±0.71</td>
</tr>
</tbody>
</table>

CONCLUSION
The higher Ktrans, fBV, and rCBV values were consistent with the high vascularity and poor vascular integrity of recurrent tumors. Both DCE and DSE for the nine patients in the table decreased following therapy. However, only Ktrans values and mean bolus wash-in slopes were statistically significant (p = 0.043 and 0.015, respectively). Fractional blood volume and rCBV were not significant (p = 0.22 and 0.051, respectively). These p values suggest that the mean bolus wash-in slope from DCE is the most sensitive parameter for detecting hemodynamic changes during this treatment time window.

KEY WORDS: Bevacizumab, antiangiogenic, gliomas

Perfusion, Diffusion and MR Spectroscopy as Biomarkers for Vascular and Cellular Infiltrative Changes in Patients following Treatment with Bevacizumab Antiangiogenic Therapy

De Villiers, L. • Law, M. • Aragoa, M. d. V. • Fatterpekar, G. • Leeds, N. • Naidich, T. • Fowkes, M. • Aiken, R.
Mount Sinai Medical Center
New York, NY

PURPOSE
Avastin® (Bevacizumab, the anti-VEGF monoclonal antibody). Bevacizumab (Avastin) has been utilized recently in combination with Irinotecan (CPT-11) for the treatment of recurrent high-grade glioma (HGG). We determine the effects of this antiangiogenic agent on perfusion, diffusion and MR spectroscopic biomarkers of tumor biology.

MATERIALS & METHODS
Twelve patients with recurrent HGG (6 females and 6 males, median age 57 years, (range 51-69 years) were treated with one to four cycles of Avastin® and Irinotecan®. Patients had baseline MRI, dynamic susceptibility perfusion MRI (DSC MRI), diffusion-weighted imaging (DWI) and MR spectroscopy (MRS) prior to the administration of Avastin and Irinotecan and were followed clinically and radiographically with conventional and advanced MRI. Mixed model regression was used to compare the pretreatment and posttreatment levels of each response measure (rCBV, ADC, Cho, T1, T2/FLAIR).

RESULTS
There was a statistically significant reduction in both rCBV and T1 size following treatment with Avastin® and Irinotecan® (p < 0.05). The rate of rCBV decrease was more rapid than the decrease in T1 enhancement. The first follow-up imaging was performed with a mean of 66 days following commencement of Avastin. The mean duration of follow up was 258.6 days (range 59 to 440). Concurrently, there was a significant decrease in ADC, increase in Cho, Cho/NAA and Cho/Cr ratios following Avastin. In some cases there appeared to be decrease in ADC and increase in Choline beyond the initial tumoral margins suggesting a gliomatosis-like infiltration of the surrounding tissues.

CONCLUSION
rCBV can be used as a biomarker to determine therapeutic response to Avastin®. This may provide an earlier indicator than conventional imaging and clinical response in the assessment of novel therapies in the treatment of primary and recurrent gliomas. However, there also appeared to be a concurrent increase in tumor cellularity and invasiveness as measured with DWI and MRS, possibly as a result of “normalization” of the tumor vascularity or change in tumor biology. Clinical Relevance/Application: Novel antiangiogenic agents are used in the treatment of primary gliomas. Perfusion MR is used in the assessment of these agents in research and in the pharmaceutical testing/approval of these drugs.

KEY WORDS: Perfusion, diffusion-weighted imaging, Bevacizumab
Paper 100 Starting at 4:50 PM, Ending at 4:58 PM

Imaging Patterns of Treatment Failure in Glioma Patients Treated with Bevacizumab

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Purpose
Recently antiangiogenic therapies such as bevacizumab have led to new forms of tumor treatment. Antiangiogenic agents lead to reduction in tumor volume and enhancement in responders. However, in nonresponders, the progressive tumor may not show enhancement, which has been used traditionally as a way to monitor tumor volume and response to treatment, and may still keep growing as nonenhancing tumor. The purpose of our study was to compare retrospectively conventional and functional MR imaging features of tumor recurrence in patients undergoing treatment with bevacizumab alone or bevacizumab plus other chemotherapies.

Materials & Methods
Twenty patients with brain tumors (GBM=16, anaplastic astrocytoma=1, astrocytoma=1, anaplastic oligoastrocytoma=1, oligoastrocytoma=1) treated with bevacizumab alone or bevacizumab plus chemotherapy (five patients on bevacizumab alone, 14 patients on bevacizumab and Irinotecan and one patient on bevacizumab and Temodar) were included in this study (16 males and 4 females) age ranging from 32-67 years; mean age of 50.9 years. An informed consent was obtained from all patients. These patients were followed up for a period ranging from 146-396 days, mean of 288.3 days with serial conventional and functional MR imaging. We retrospectively reviewed diffusion maps in all these patients and ADC values were obtained by drawing regions of interest (ROIs) by a combination of thresholding and manual tracing using an interactive software package (Eigentool, http://www.radiologyresearch.org/eigentool.htm) for the gadolinium-enhancing region and region of FLAIR abnormality. These gadolinium and FLAIR ROIs were superimposed on diffusion maps on the serial MR studies to obtain ADC values using image coregistration (Eigentool). We also calculated the tumor volumes based on the enhancing gadolinium and FLAIR abnormality using the same software. In addition we also reviewed the conventional MR imaging findings in this group of patients. Patients were divided into two groups based on imaging and clinical criteria of responders/stable disease and nonresponders/progressive disease.

Results
Ten patients classified as responders based on volumetric measurements showed decreasing or stable gadolinium and FLAIR volumes. Ten patients who were classified as nonresponders, only four out of these 10 showed increase in gadolinium volumes whereas six patients showed reduction in gadolinium volumes. However, more importantly, seven out of these 10 nonresponders, showed decrease in ADC values suggesting hypercellular progressive tumor.

Conclusion
Treatment failure with patients on bevacizumab showed areas of nonenhancing yet hypercellular tumor component suggesting that there may be regions within a tumor which may not respond to antiangiogenic therapy. Hence follow-up imaging criteria of measuring enhancement to assess response to a treatment may not be sufficient in patients on antiangiogenic therapy and some other functional imaging markers such as ADC values may be required to be included in the follow-up assessment.

Key Words: Diffusion imaging, treatment failure, bevacizumab

Paper 101 Starting at 4:58 PM, Ending at 5:03 PM

Focal Neuronal Gigantism: A Rare Complication of Radiation Therapy

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Purpose
Radiation therapy, a mainstay in the treatment of many brain tumors, results in a variety of well documented acute and chronic complications. Isolated cortical damage following irradiation represents an extremely rare delayed therapeutic complication, described only twice in medical literature and never before in the radiology literature. We present this rare delayed complication in a patient following treatment of a right frontal anaplastic oligoastrocytoma.

Case Report
A 53-year-old female with a history of anaplastic oligoastrocytoma presented to her neurosurgeon following a surveillance MRI concerning tumor progression. She had been treated initially 9 years previously with surgical resection, chemotherapy, and irradiation. Serial MRI had demonstrated a stable appearance for the 4 years prior to presentation. MR imaging at presentation demonstrated interval development of thickening and nodular enhancement of the right frontal cortex surrounding the resection cavity, which represented a dramatic change. Because of the concern for tumor progression, surgical biopsy was performed. Specimen evaluation demonstrated cortical thickening, massive cortical gliosis, and neuronal cytomegaly, with multifocal demyelination and vascular hyalinization of the underlying white matter. The histologic appearance most closely resembled that seen in cortical dysplasia, with no evidence of tumor.

Imaging Findings
MR performed at the time of presentation demonstrated prior right frontal craniotomy and cystic encephalomalacia of the resection cavity, with abnormal enlargement and nodular enhancement of the cortex and juxtacortical white matter surrounding the resection cavity, with extensive edema-like signal throughout the surrounding white matter. These findings represented a dramatic change from the MR study performed a year previously. At that time, MR imaging showed postoperative changes and encephalomalacia, with no significant enhancement around the resection cavity, imaging findings that had remained stable for the previous four years.
SUMMARY

Focal neuronal gigantism represents a rare delayed complication following radiation therapy, never before reported in radiology literature.

KEY WORDS: Radiation, complication, neoplasm

Paper 102 Starting at 5:03 PM, Ending at 5:08 PM

Acute Pituitary Macroadenoma Apoplexy with Intraventricular Rupture during In-Hospital Presurgical Work Up

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PURPOSE

We present a striking case of acute pituitary apoplexy within a large macroadenoma that ruptured into the ventricular system causing acute hydrocephalus while the patient was being worked up in hospital for resection.

MATERIALS & METHODS

Patient is a 19-year-old female with an 8-month history of blurry vision which worsened to include loss of peripheral vision 2-3 months prior to admission. She was found to have a bitemporal hemianopsia and laboratory studies showed elevated prolactin and IgF1 levels, felt to represent stalk effect. Admission CT scan and MRI were performed (see below) which both showed a sellar/suprasellar mass. Patient was being evaluated for surgical intervention of a pituitary macroadenoma when on the evening of hospital day three the patient developed a headache and confusion. An emergent MRI was done (see below) which showed apoplexy with rupture into the ventricles and acute hydrocephalus. The patient was emergently taken to surgery for transsphenoidal resection. During surgery, upon incision of the dura, tumor began to extrude due to the obvious increased pressure. Apoplexy was confirmed with areas of blood, clot, and CSF within the mass. Pathology confirmed a macroadenoma with sparsely granulated growth hormone immunoactivity.

RESULTS

Admission CT scan revealed a sellar/suprasellar mass with remodeling of the sella turcica. MR imaging the same day showed a 3.8 x 2.3 x 2.3 cm solid mass that superiorly displaced the optic chiasm, with no cystic components and no calcification. No intracranial hemorrhage was seen on CT scan or MRI. Emergent MRI 3 days later showed a change in signal and contour of the mass, with the superior margin newly indistinct and lacking enhancement, and new intraventricular hemorrhage/debris and hydrocephalus.

CONCLUSION

We demonstrate an unusual case of pituitary macroadenoma with acute apoplexy that decompressed into the ventricular system during in-hospital presurgical work up.

KEY WORDS: Apoplexy, pituitary macroadenoma, intraventricular hemorrhage
**Purpose**
To evaluate the role of apparent diffusion coefficient value in differentiation between malignant and benign solitary thyroid nodule.

**Materials & Methods**
Prospective study was conducted on 67 consecutive patients with solitary thyroid nodule underwent diffusion MR imaging of the thyroid gland. Diffusion-weighted MR images were acquired with b-factor of 0, 250 and 500 sec/mm² using single-shot echo-planar imaging. Apparent diffusion coefficient (ADC) maps were reconstructed. The ADC values of the solitary thyroid nodules were calculated and correlated with the results of histopathologic examination. Statistical analysis was done.

**Results**
The mean ADC value of malignant solitary thyroid nodules was $0.73 \pm 0.19 \times 10^{-3}$ mm²/sec and of benign nodules was $1.8 \pm 0.27 \times 10^{-3}$ mm²/sec. The mean ADC values of the malignant nodules were significantly lower than those of benign ones ($P = 0.0001$). An ADC value of $0.98 \times 10^{-3}$ mm²/sec was proved as a cut-off value differentiating between benign and malignant nodules, with 97.5%, 91.7% and 98.9% (sensitivity, specificity and accuracy respectively).

**Conclusion**
Apparent diffusion coefficient value is a new promising non-invasive imaging approach used for differentiating malignant from benign solitary thyroid nodule.

**Key Words:** Diffusion, thyroid, nodule

**Paper 104 Starting at 3:38 PM, Ending at 3:46 PM**

**Bone within Bone Appearance: A Red Flag for Biphosphonate-Associated Osteonecrosis of the Jaw**

Fatterpeker, G. M. · Pelaez, M. · Vibhute, P. · Delman, B. N. · Doshi, A. H. · Law, M. · Ando, K. · Naidich, T. P. · Som, P. M.
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**Purpose**
Osteonecrosis of the jaws is recognized as a serious complication of biphosphonate therapy. The purpose of this study was to characterize the CT imaging appearance of biphosphonate-associated osteonecrosis (BAON), and to evaluate for distinguishing features from radiation-induced osteonecrosis (RION) and osteomyelitis (OM).

**Materials & Methods**
We retrospectively reviewed CT scans of six patients with biopsy proved biphosphonate-associated osteonecrosis (BAON). CT scans were evaluated for presence of periosteal reaction, cortical erosion, reactive sclerosis, fragmentation and collapse of the underlying bone, destruction of the underlying trabecular bone manifested as radiolucency, sequestrum and presence of any underlying bone expansion. Examinations also were assessed for presence of associated soft tissue mass. For comparison, we also retrospectively analyzed CTs of five patients with radiation-induced osteonecrosis (RION) of the jaw and six patients with osteomyelitis (OM).

**Results**
As the table demonstrates, an expansile lytic lesion with central sequestrum is highly suggestive of BAON. These sequestra tended to be very thick. This resulted in a “bone within bone” appearance in five of six cases. No RION or OM cases demonstrated an expansile lytic process. Instead, all the RION cases showed fragmentation and collapse of the underlying bone. Presence of cortical erosion, reactive sclerosis, radiolucency and associated soft tissue mass should raise the possibility of OM in the appropriate clinical setting.

**Radiographic Criteria to Evaluate BAON from RION and OM**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>BAON</th>
<th>RION</th>
<th>OM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periosteal reaction</td>
<td>3/6</td>
<td>0/5</td>
<td>3/6</td>
</tr>
<tr>
<td>Cortical erosion</td>
<td>5/6</td>
<td>5/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Reactive sclerosis</td>
<td>6/6</td>
<td>3/5</td>
<td>6/6</td>
</tr>
<tr>
<td>Fragmentation and collapse of bone</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
</tr>
<tr>
<td>Radiolucency</td>
<td>6/6</td>
<td>6/5</td>
<td>6/6</td>
</tr>
<tr>
<td>Bone expansion</td>
<td>5/6</td>
<td>0/5</td>
<td>0/6</td>
</tr>
<tr>
<td>Sequestrum</td>
<td>6/6</td>
<td>0/5</td>
<td>3/6</td>
</tr>
<tr>
<td>Associated soft tissue</td>
<td>4/6</td>
<td>1/5</td>
<td>6/6</td>
</tr>
</tbody>
</table>

*Note: The numbers represent the proportion of cases that met each criterion.*
CONCLUSION
In an appropriate clinical setting, a “bone within bone” appearance should alert the clinician to the possibility of biphosphonate-associated osteonecrosis (BAON).

KEY WORDS: Biphosphonate, radiation, osteonecrosis

Paper 105 Starting at 3:46 PM, Ending at 3:54 PM
Orbital MR Imaging in Idiopathic Intracranial Hypertension: A New Sign

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PURPOSE
Determine the optic sheath: optic nerve diameters ratio in cases of clinically proved IIH with correlation to the lumbar puncture opening pressure.

MATERIALS & METHODS
Orbital MR images of 65 patients with clinically proved IIH and orbital MRI findings supportive of this diagnosis were reviewed retrospectively by the author. The orbital MRI showed optic disk elevation, nerve sheath distention and optic nerve kinking in all patients. The lumbar puncture opening pressure was measured in all cases. MR imaging of the orbits were performed using 1.5 T MRI systems and images were obtained in all three orthogonal planes using T2 FSE with fat saturation, routine T1 SE and post gadolinium T1 SE with fat saturation. The transverse diameters of the optic nerve sheaths and optic nerves were measured on the MRI work station using the commercially provided measurement tool. This was done at the middle point of the orbital segment of the optic nerve using the T2-weighted orbital coronal images. The ratio between the two measurements was calculated.

RESULTS
In 53 patients (81.5%) with lumbar puncture opening pressure more than 300 mm H2O the optic sheath diameter was at least twice the optic nerve diameter. In the other 12 patients (18.5%) had lumbar puncture opening pressure less than 300 mm H2O and the optic sheath diameter was less than twice the optic nerve diameter.

CONCLUSION
Optic sheath: optic nerve diameters ratio more than 2:1 is a reliable sign of IIH with lumbar puncture opening pressure more than 300 mm H2O.

KEY WORDS: Orbit, pseudotumor cerebri

Paper 106 Starting at 3:54 PM, Ending at 4:02 PM
Role of Diffusion-Weighted Echo-Planar MR Imaging in Differentiation of Residual/Recurrent Head and Neck Tumors and Posttreatment Changes

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PURPOSE
To evaluate whether diffusion-weighted MR imaging can be used in differentiating residual or recurrent head and neck tumors from postoperative or postradiation changes.

MATERIALS & METHODS
This study included 32 patients clinically suspected for recurrent head and neck tumor after surgery (n = 3), radiotherapy (n = 13) or both (n = 16). Diffusion-weighted MR imaging was done using a single shot spin-echo echo-planar sequence. The ADC value of suspected lesion was calculated and correlated with pathologic results.

RESULTS
Adequate diffusion-weighted MR images and ADC maps were obtained in 30 (93.8%) patients. The mean ADC value of residual or recurrent lesions (1.17 ± 0.33 X 10-3 mm2/sec) was less than that of posttherapeutic changes (2.07 ± 0.25 X 10-3 mm2/sec) and the difference was statistically significant (P < 0.001). When an ADC value of 1.30 X 10-3 mm2/sec was used as a threshold value for differentiation, the best results were obtained with an accuracy of 87%, sensitivity of 84%, specificity of 90%, and positive predictive value of 94% and negative predictive value of 76%.

CONCLUSION
Diffusion-weighted MR imaging with ADC measurement has promising results for differentiating residual or recurrent head and neck tumors from postoperative or postradiation changes.

KEY WORDS: Diffusion, recurrence, radiation
Role of Dynamic Susceptibility Contrast Perfusion MR Imaging in Differentiation between Benign and Malignant Head and Neck Tumors

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Purpose
To determine the role of dynamic susceptibility contrast perfusion-weighted MR imaging in differentiation between benign and malignant head and neck tumors.

Materials & Methods
Eighty-one patients (52 male and 29 female aged ranged from 18 years to 71 years: mean age 43 years) with head and neck mass underwent single-shot dynamic susceptibility contrast T2*-weighted perfusion-weighted MR imaging following administration of a bolus of gadopentate dimeglumine in a dose of 0.3 mmol/ kg body weight. The injection was performed by automatic injector in the right arm at a rate of 5 ml/s followed by 20 ml saline. Image acquisition was repeated every 2 seconds and data acquisition time was 120 seconds. The signal intensity time curve of the lesion was created. Percentage of maximum signal intensity loss was calculated and correlated with pathologic findings. Statistical analysis and receiver operating curve was done.

Results
The percentage of the mean signal intensity loss of malignant tumor (n = 40) was 39.37 ± 9.6% and of benign lesions (n = 38) was 24.32 ± 10.3%. There was statistically significant difference of the mean percentage of signal intensity loss between benign and malignant tumors (P < 0.001), within malignancy (P < 0.002) and benign tumors (P < 0.001) as well as within the different grades of malignant tumors (P < 0.001). When maximum signal intensity loss value of 30.75 was used as a threshold value for differentiating malignant from benign head and neck tumors, the best results were obtained with an accuracy of 84.6%, sensitivity of 80%, specificity of 89.2%, positive predictive value of 88% and negative predictive value of 81.68%.

Conclusion
Dynamic susceptibility contrast perfusion-weighted MR imaging is a new promising noninvasive imaging modality that can play a role in differentiation between benign and malignant head and neck tumors as well as for histopathologic grading of malignant tumors.

Key Words: Head and neck, tumor, perfusion MR imaging
which all four glands are identified in the bilateral neck. Ultrasound (US) is the first line imaging modality at our institution, and in our experience is able to localize successfully parathyroid adenomas in greater than 80% of cases. However, high-resolution contrast-enhanced computed tomography (CT) may be able to accurately localize parathyroid adenomas, and could serve a complementary role to other first-line imaging modalities such as ultrasound and technetium-99 sestamibi nuclear scintigraphy (sestamibi) in more challenging cases.

**Materials & Methods**

We reviewed our 5-year experience (2001-2006) of surgical treatment for primary hyperparathyroidism and identified 223 neck explorations for removal of parathyroid adenomas. Although most were localized successfully sonographically, up to one third of cases were complicated by negative or equivocal sonographic studies, conflicting US and sestamibi results, and/or altered postoperative anatomy. For these patients (76/223), CT was performed. We retrospectively and independently reviewed these 76 CTs, blinded to clinical and other imaging data, in order to better characterize CT features of parathyroid adenomas. Size (long axis measurement on greatest axial image slice dimension), enhancement pattern, and location (based on suspected gland of origin) were reported by three experienced reviewers. Disagreements were resolved by consensus. Review of the surgical record was considered the gold standard for localization. For surgically indeterminate glands (2.6%), only the side of lateralization was used to determine a true positive CT finding.

**Results**

Fifty-six female and 20 male patients underwent enhanced CT for parathyroidectomy planning. Twenty-six of 76 (34.2%) of exams were performed for planned reexploration of failed prior parathyroidectomy. Adenoma size ranged from 5 to 26 mm (average 11.5 mm). Adenomas demonstrated vascular type enhancement in 40/50 (80%) and were isodense to muscle in 10/50 (20%) of the correctly identified adenomas. There were 26 right superior, 21 right inferior, 10 left superior, and 17 left inferior glands identified surgically. There were two cases (2.6%) that were indeterminate with respect to superior versus inferior gland origin at surgery. CT correctly localized parathyroid adenomas in 50/76 (65.8%) of studies and in 16/26 (61.5%) of those presenting for repeat exploration.

**Conclusion**

Contrast-enhanced neck CT correctly localized parathyroid adenomas in 65% of patients. Notably, CT was performed in a difficult patient population in whom first-line localizing studies were nonlocalizing or demonstrated equivocal results. Over one third of studies were performed in patients with complicated postsurgical anatomy. Despite the high degree of diagnostic accuracy with ultrasound, clinical uncertainty regarding secure localization resulted in additional imaging with CT in 34% of patients. CT therefore represents a promising secondary modality when first-line imaging fails for localization of parathyroid adenoma. Knowledge of the normal CT appearance, enhancement and expected location are critical to correct interpretation of parathyroid adenoma on CT.

**Key Words:** Parathyroid, adenoma

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**Paper 110 Starting at 4:26 PM, Ending at 4:34 PM**

**Perfusion CT and Glucose Uptake Measurements in Squamous Cell Carcinoma of the Head and Neck: Agreement in Tumor Delineation and Correlation of their Values**

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**Purpose**

To compare perfusion CT (PCT) and fluorine-18-fluorodeoxyglucose (FDG) positron emission tomography (PET) studies for tumor tissue delineation, as well as to quantify and correlate indices provided by both modalities in patients with squamous cell carcinoma (SCC) of the head and neck.

**Materials & Methods**

Ten patients with histologically proved primary and recurrent SCC [7 male, 3 female, mean age (SD): 61.4 years ± 11.3] underwent PCT and FDG PET CT studies at the same time using a 16-slice PET CT unit. Images after dedicated head/neck acquisitions were produced from ordered subset expectation maximization (OSEM) reconstructions with filtering (2 iterations of 30 subsets utilizing a Gaussian blurring filter). Orthogonal slices images were interpreted using standardized preset window level. Perfusion CT maps that represented blood flow (BF) (in mL/min/100g), blood volume (BV) (in mL/100g), mean transit time (MTT) (in s), and permeability (PS) (in mL/min/100g) also were generated using deconvolution-based analysis. Two neuroradiologists in consensus outlined the tumor borders separately in the BF PCT maps and in the PET CT maps. Gross tumor volume and whole tumor quantitative perfusion, and mean (SUV<sub>mean</sub>) and maximum standardized uptake values (SUV<sub>max</sub>) were recorded. T-test was performed to measure agreement between gross tumor volume measurements. Pearson correlation coefficients were applied to examine for statistically significant relationship between perfusion values and maximum SUV.

**Results**

The delineation of tumor tissue was in close agreement between PCT (24.04 mL) and PET (20.82 mL) studies (p-value = 0.42). The means of BF, BV, MTT, PS values in the SCC were 99.38±46.85, 6.46±1.87, 7.85±2.67, 20.15±8.26. All perfusion parameters were significantly different between SCC and muscle tissue (0.0001<p-value<0.01). The maximal SUV in the muscle tissue and in the tumor sites was 1.74±1.21 and 20.59±8.45, respectively. Significant correlation was revealed between BF and both SUV<sub>mean</sub> and SUV<sub>max</sub> (r=0.75 and r=0.82 (p-value<0.0001, respectively), as well as between MTT and SUV<sub>mean</sub> and SUV<sub>max</sub> (r=0.49 and r=0.45, p-value<0.03). Significant correlations were not observed between BV and SUV<sub>max</sub> (r=0.56, p-value=0.1) and PS and SUV<sub>max</sub> (r=0.18, p-value=0.4). Similarly, significant correlations were not demonstrated between BV, PS values and SUV<sub>mean</sub>.

**Conclusion**

The delineation of tumor tissue based on either PCT or FDG PET maps is feasible and does not lead to significantly different values. A significant positive correlation was found between both BF and MTT with both SUV<sub>mean</sub> and
**SUV**\(_{\text{max}}\), indicating that coupling between BF as well as MTT and glucose uptake may exist in head and neck tumors.

**KEY WORDS:** PET CT, perfusion CT

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**Paper 111 Starting at 4:34 PM, Ending at 4:42 PM**

**Applicability of Relative Standardized Glucose Uptake Value in PET CT Studies of Head and Neck Tumors: Which Ratio Is More Reproducible in Response Monitoring Trials?**

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Charleston, SC

**PURPOSE**
The variability of mean and maximum glucose uptake value (SUV) in head and neck tumors is a major drawback in longitudinal studies. We hypothesize that this may be overcome by defining tumor SUV relative to nontumor tissues and to determine which ratio of tumor to normal tissue SUV is optimally reproducible for follow-up studies in head and neck tumors.

**MATERIALS & METHODS**
Fifteen patients (mean age ±SD 60 ±11 years) with histologically proved primary tumors in the head and neck underwent PET CT examinations of the whole body including a dedicated head and neck PET CT acquisition. The patients were reexamined after 5.4 ±1.7 months for follow up of the treated tumors. Maximum (SUV\(_{\text{max}}\)) and mean (SUV\(_{\text{mean}}\)) SUVs were measured from both sessions using standardized regions of interest (ROIs) in left frontal cortex (85 mm\(^3\)) and in right psoas muscle (65 mm\(^3\)) for both PET CT surveys. Reproducibility analysis including Bland-Altman plots were performed in order to identify the more reproducible measurement.

**RESULTS**
The mean SUV\(_{\text{max}}\) in the tumors was 15.3±4.1 (95% CI: 9.9-20.5). The mean ratio (Ratio 1) of tumor SUV\(_{\text{max}}\) to cortex SUV\(_{\text{max}}\) was 1.2±0.7 (95% CI: 0.85-1.58). The mean ratio (Ratio 2) of tumor SUV\(_{\text{max}}\) to psoas SUV\(_{\text{max}}\) was 15.5±5.5 (95% CI: 11.8-19.2). The coefficient of variation for Ratio 1 was 66.4% and the coefficient of variation for Ratio 2 was 35.2%. The mean SUV\(_{\text{max}}\) in frontal cortex was 9.2±3.5 in the first session and 10.1±4.9 in the re-session. The mean difference was 3.1 and the 95% limits of agreement were -5.5 to 7.8. The mean SUV\(_{\text{max}}\) in the psoas muscle was 1.1±0.3 and 1.0±0.2 in the first and follow-up examinations, respectively. The mean difference was 0.03 and the 95% limits of agreement were -0.9 to 0.7. The within-subject coefficient of variation, the repeatability coefficient, and the significant change for a single subject for the SUV in frontal cortex were 30%, 39.58, and 85%, respectively. The within-subject coefficient of variation, the repeatability coefficient, and the significant change for a single subject for the SUV in psoas muscle were 8%, 0.75, and 28%, respectively. The mean SUV\(_{\text{mean}}\) followed the same pattern of reproducibility as the SUV\(_{\text{max}}\).

**CONCLUSION**
The SUV\(_{\text{max}}\) and SUV\(_{\text{mean}}\) measurements of psoas muscle are more reproducible than the corresponding measurements in frontal cerebral cortex, and the head and neck tumor SUV to psoas muscle SUV ratio is more suitable than the tumor SUV to cerebral cortex SUV ratio for evaluating longitudinal head and neck studies and response trials.

**KEY WORDS:** PET CT

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**Paper 112 Starting at 4:42 PM, Ending at 4:50 PM**

**Head and Neck Cancer PET/CT: Patterns of Distant Disease**

Nissman, D. B. · Rumboldt, Z. · Gordon, L.
Medical University of South Carolina
Charleston, SC

**PURPOSE**
Determine the prevalence of metastatic disease outside the head and neck and below the diaphragm for head and neck cancers by histologic type as determined by PET/CT and verified by biopsy and follow up.

**MATERIALS & METHODS**
All PET/CT scans performed for patients with a diagnosis or findings strongly suggestive of a head and neck cancer were reviewed since our scanner was installed in February 2006 through March 31, 2007. Four diagnostic categories were used: squamous cell carcinoma (SCCa); thyroid cancer (any histology); nonsquamous cell, nonthyroid cancers; and, unknown - undiagnosed new head and neck masses or signs suggestive of a head and neck cancer. Cases were coded according to site of most distant disease. Proportions of disease outside the head and neck and below the diaphragm were computed. Descriptive statistics and comparisons by diagnostic group were performed.

**RESULTS**
Over the 13-month period, 308 PET/CT scans were performed on 264 patients. One scan was nondiagnostic and was not included in the analysis. Number of scans (patients) by diagnostic category: SCCa - 199 (170), thyroid cancer - 29 (24), non-SCCa, nonthyroid - 51 (42), and unknown - 28 (28). Four unknown case patients were reassigned on subsequent scans. Distant disease outside the head and neck was observed in 12% of patients with SCCa, 29% of patients with thyroid cancer, 24% of patients with a non-SCCa, nonthyroid cancer, and 14% of patients with an unknown head and neck process. Distant disease below the diaphragm was observed in 4%, 13%, 7%, and 7% in those same categories, respectively. The overall distributions of disease for each diagnostic category were significantly different between the SCCa group versus the other three groups (p < 0.001). Of the 39 patients with more than one scan, disease burden increased in 14%, decreased in 28%, and was unchanged in 58% between their first and last scan. Final pathology is still pending on several cases with distant disease.

**CONCLUSION**
Squamous cell carcinoma originating in the head and neck is less likely to be associated with distant disease, true metastatic or second primary malignancy, below the diaphragm (only 4% in our sample) than other head and neck cancer types as determined by PET/CT at our institution.

**KEY WORDS:** PET, squamous cell carcinoma, metastatic disease
Orbital Mesenchymal Chondrosarcoma: Imaging Features of an Unusual Neoplasm

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PURPOSE
To discuss the clinical and radiographic features of a case of extraskeletal mesenchymal chondrosarcoma of the orbit that recently presented at our institution.

CASE REPORT
A 24-year-old female presented with right eyelid swelling and a palpable right eye “bump” for 2 months. The patient reported a feeling of pressure but no pain. Examination revealed a soft, rubbery, nontender mass between the trochlea and the supraorbital notch in the right superonasal orbit as well as right eye proptosis. A contrast-enhanced CT of the orbit was performed demonstrating the lesion. The patient underwent surgical resection with the specimen sent to pathology. Histologic findings confirmed the diagnosis of extraskeletal mesenchymal chondrosarcoma of the orbit.

IMAGING FINDINGS
CT of the orbits showed a well circumscribed mass measuring 3.0 cm in maximal diameter with a peripheral rim of enhancing soft tissue and coarse central calcification. The mass was primarily in the intraconal space and caused proptosis and inferolateral displacement of the globe. No erosive changes of the bony orbit were identified.

Figure 1. Well calcified lesion identified within the superior-medial aspect of the right orbit.

SUMMARY
Mesenchymal chondrosarcoma is a rare tumor. Orbital presentation has been reported previously in 18 cases (1-3). It occurs most often in the second and third decades of life, can occur anywhere in the body and is seen more often in females (1-2). Patients typically present with proptosis and decreased visual acuity. The tumor is grossly lobulated, firm, focally calcified or cartilaginous and often vascular (3). It is composed of an admixture of undifferentiated mesenchymal cells and islands of well differentiated cartilage. Surgical resection is the treatment of choice. Chemotherapy and radiation are considered if the lesion is not fully resectable. Prognosis for patients with mesenchymal chondrosarcoma is generally poor but prognosis for survival is better in patients with orbital lesions based on limited data.

REFERENCES
1. Lichtenstein L, Bernstein D. Unusual benign and malignant chondroid tumors of bone: a survey of some mesenchymal cartilage tumors and malignant chondroblastic tumors including a few multicentric ones and chondromyxoid fibromas. Cancer 12;1959:1142-1157

KEY WORDS: Chondrosarcoma, orbit, extraskeletal

Juvenile Xanthogranuloma of the Orbit

Tuthill, H. L. · Sklar, E. · Bhatia, R.
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PURPOSE
Non-Langerhans cell histiocytic disorders encompass a spectrum of entities that are rarely encountered; an example of one of these entities, juvenile xanthogranuloma, and its characteristic radiologic features, are highlighted.

CASE REPORT
An otherwise healthy eight-month-old boy developed gaze abnormalities and progressive, unilateral proptosis; initial MR imaging demonstrates a retrobulbar, superior orbital mass, biopsy of which revealed juvenile xanthogranuloma, with tumor cells infiltrating the extraocular muscle fibers.

IMAGING FINDINGS
Magnetic resonance imaging depicts an infiltrative, mildly enhancing retrobulbar mass, T1 isointense/T2 hypointense to extraocular muscles, filling the superior orbit, inseparable from the superior rectus muscle, abutting the optic nerve sheath complex, involving both intraconal and extraconal spaces, displacing the globe with resultant proptosis, and extending posteriorly towards the orbital apex. There are no classic imaging findings of this entity, as the vast majority of juvenile xanthogranulomas are cutaneous. Reports in the literature describe extracutaneous lesions as homogenous masses, hypointense to isointense in T1, of variable T2 signal intensity, most often T2 isointense, with enhancement following gadolinium administration.
SUMMARY
The classic presentation of juvenile xanthogranuloma, one of the non-Langerhans cell histiocytic disorders, is a male infant with cutaneous, skin-colored nodules. However, this disease rarely involves extracutaneous sites (3.9%); involvement has been reported in the central nervous system, globe, tongue, skeletal muscle, heart, lungs, liver, kidney, and spleen, as well as in the orbit, as this case exemplifies, which is the most common extracutaneous location. Ten percent of cases occur in adults. Either forming a discrete mass, or acting in an infiltrative manner, systemic juvenile xanthogranuloma often behaves in a more sinister manner than its cutaneous form, even leading to death. Efforts to classify the histiocytic disorders based upon evolved laboratory techniques, as well as increased recognition of these entities, may lead to better understanding, detection, and treatment.

KEY WORDS: Juvenile xanthogranuloma

**Monday Afternoon**
3:30 PM – 5:00 PM
Room 211/212

(12d) PEDIATRIC: Neoplasms & New Techniques/Excerpta
(Scientific Papers 115 – 126)

See also Parallel Sessions
(12a) ADULT BRAIN: Cerebrovascular Occlusive Diseases
(12b) ADULT BRAIN: Neoplasms I
(12c) HEAD & NECK: Orbital Faces and New Techniques

Moderators: Tina Young Poussaint, MD
Gilbert Vezina, MD

Paper 115 Starting at 3:30 PM, Ending at 3:38 PM
Quantitative Comparison of T2*- and T1-Based Perfusion Measurements in Pediatric Brain Tumors: A Report from the Pediatric Brain Tumor Consortium

Roberts, T. P. L. 1 · Vajapeyam, S. 2 · Khrichenko, D. 1 · Kocak, M. 1 · Young-Poussaint, T. 2

1Children’s Hospital of Philadelphia, Philadelphia, PA, 2Children’s Hospital Boston, Boston, MA, 3St. Jude Children’s Research Hospital, Memphis, TN

PURPOSE
Assessment of perfusion characteristics, such as cerebral blood volume (CBV), is useful in assessing tumor grade and response to therapy, particularly treatment with antiangiogenic drugs. Two main MRI approaches have been used for monitoring bolus passage of Gd-based contrast agent: T2*-weighted first pass imaging and T1-weighted “pseudo steady-state” imaging. The purpose of this study was to quantitatively compare CBV determinations from each technique in pediatric brain tumors, prior to antiangiogenic therapy.

MATERIALS & METHODS
Fifteen children with recurrent intracranial tumors were enrolled in either of two antiangiogenic pharmaceutical protocols. Baseline (pretreatment) imaging (in addition to standard MR images) consisted of both 3D T1-weighted dynamic contrast-enhanced (DCE) MRI and multislice T2*-weighted EPI first pass imaging, with separate 0.1mmol/kg Gd-based bolus administrations. Regions of interest were placed in the area of tumor assessed as maximally enhancing on T1-weighted images. Regions of interest were transferred manually to homologous regions on T2*-weighted series. Dynamic signal intensity time courses were obtained for
tumor, and also for sagittal sinus. For $T_2^*$-weighted series, computation of $\Delta R^2$ was made and rCBV was computed as the area under the $\Delta R^2$ time curve. An estimate of absolute CBV was made by normalization to sagittal sinus. For $T_1$-weighted series, a modified Tofts model was used (2-compartment, bi-directional flux) to estimate both fractional blood volume (fBV) and microvascular permeability (Kps). Values of CBV and fBV derived from the two methods were compared using a nonparametric permutation test (to assess magnitude differences), and Spearman rank-correlation coefficient (to assess correlation, or systematic trends). Similar analyses were performed in normal-appearing brain tissue. Eleven successful studies are presented from patients with recurrent supratentorial glioma (6) and brainstem glioma (5). On $T_1$-weighted imaging, the median fBV for the brain tumors was 0.075 (range: 0.015-0.42). Based on $T_2^*$-weighted imaging, CBV values were 0.143 (range: 0.078-0.46). By Exact Permutation test, fBV and CBV for tumors have significantly different distributions, p=0.003.

Furthermore, for $T_1$-weighted imaging, the median fBV for normal brain was 0.039 (range: 0.017-0.104); $T_2^*$-weighted imaging had a much higher median value of 0.078 (range: 0.051-0.17), which resulted in significant difference between the two techniques for normal brain, p=0.001. Rank-correlation between fBV values derived from $T_1$-weighted imaging and CBV derived from $T_2^*$-weighted imaging for brain tumors was strong ($r=0.65$, $p=0.032$).

RESULTS
Dynamic $T_2^*$ and $T_1$-weighted imaging during Gd-bolus administration can be analyzed to yield estimates of cerebral blood volume. Although measures derived from each method correlate well, absolute CBV values from $T_2^*$-weighted imaging are significantly higher than those from $T_1$-weighted imaging for both tumor and normal brain, which for the $T_1$-based approach are consistent with existing literature. $T_2$-methods also have the advantages of better spatial resolution and reduced artifact sensitivity.

CONCLUSION
Further analyses of these two techniques with a larger cohort and within clinical trials likely will determine which technique has greater advantage in terms of sensitivity to microvascular change.

KEY WORDS: CBV, microvascular, tumor

Paper 116 Starting at 3:38 PM, Ending at 3:46 PM
Dynamic Susceptibility-Weighted Contrast-Enhanced MR Imaging and Diffusion Tensor Imaging Characterization of Crossed Cerebellar Diachisis in Patients with Supratentorial High-Grade Gliomas after Surgery

Patay, Z.1; Loeffler, R.1; Laningham, F.1; Helton, K.1; Shulkin, B.1; Salibi, N.1; Bronscier, A.1; Kun, L.1; Ogg, R.1; Hillenbrand, C.1
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PURPOSE
Diachisis is a functional impairment of brain tissue in areas remote from a site of primary brain injury. Crossed cerebel-

lar diachisis (CCD) is the most commonly observed manifestation, best assessed by 18-FDG PET and SPECT, which demonstrate glucose hypometabolism and hypoperfusion in the cerebellar hemisphere contralateral to a supratentorial lesion. Dynamic susceptibility-weighted contrast-enhanced ($T_2^*$-DCE) MRI is a robust technique used to characterize brain perfusion. It provides quantitative parameters, such as cerebral blood flow (CBF) and cerebral blood volume (CBV), describing regional blood perfusion. Diffusion tensor imaging (DTI) is a sensitive indicator of white matter integrity. Objectives of our study were: 1. To determine if $T_2^*$-DCE MRI is consistently capable of demonstrating measurable hemodynamic alterations in 18-FDG PET-proven CCD in patients with surgically treated supratentorial high-grade neoplasms. 2. To determine if CCD-related hemodynamic and metabolic alterations are associated with measurable fractional anisotropy (FA) changes indicating permanent structural damage to myelinated axons.

MATERIALS & METHODS
Five patients (M/F: 5/0, age range: 10-24 years) with surgically treated supratentorial high-grade neoplasms (3 GBM, 1 anaplastic astrocytoma, 1 PNET) were included in retrospective study. 18-FDG PET, conventional MRI, $T_2^*$-DCE MRI and DTI data acquired within 30 days were reviewed and analyzed. One patient had two studies at a 5-month interval. All examinations were performed on 1.5 T magnets. Standard dose (0.1 mmol/kg) of gadolinium-based contrast agent (Magnevist) was used intravenously in bolus injection at 1 ml/sec rate. Parametric maps (rCBV, rCBF and FA) of the cerebellum were generated off-line on a dedicated work-station. Regions of interest were drawn over each cerebellar hemisphere in both gray and white matter areas; and asymmetry indices ($AI: x_{L} - x_{R}/x_{L} + x_{R}$) for all parameters were calculated.

RESULTS
In all six studies, 18-FDG PET showed metabolic depression within cerebellar hemispheres contralateral to complex supratentorial lesions (tumor and surgical damage). Cerebral blood volume and CBF within cortex of affected cerebellar hemispheres were consistently lower compared to normal side ($AI_{CBV}: 7.2\pm5.3\%$ (mean$\pm$stddev), range: 1.6-15.7%; $AI_{CBF}: 8.8\pm5.6\%$, range: 2.2-17.0%). Fractional anisotropy values within white matter of affected cerebellar hemispheres also were consistently lower than on normal side ($AI_{FA}: 2.4\pm1.8\%$, range: 0.4-4.8%). In patient who had two examinations, follow-up study showed progression of both $T_2^*$-DCE MRI and DTI changes; $AI_{CBV}$ increased from 1.6% to 10.5%, $AI_{CBF}$ increased from 2.2% to 11.6% and $AI_{FA}$ increased from 0.4% to 3.1%.

CONCLUSION
Both $T_2^*$-DCE MRI and DTI were found to be useful markers of functional changes (cortical hypoperfusion) and structural alterations (myelin damage) in CCD. Asymmetry indices were relatively low, but the single observation in a patient with follow-up study suggests that both $T_2^*$-DCE MRI and DTI abnormalities may progress with disease chronicity. Future prospective studies may allow identification of clinical factors, which may influence magnitude and dynamics of CCD and evaluate neurologic correlates. Early identification of patients at risk, using tools available at pre
and postsurgical MRI work up, may allow early institution of rehabilitative measures to limit the clinical impact of CCD.

**KEY WORDS:** Crossed cerebellar diaschisis, diffusion tensor imaging, perfusion imaging

**Paper 117 Starting at 3:46 PM, Ending at 3:54 PM**

**Diffusion Tensor Imaging Assessment of the Brainstem White Matter Tracts in Pediatric Brainstem Glioma Patients before and after Therapy: A Report from the Pediatric Brain Tumor Consortium**

Vajapeyam, S. · Ng, S. · Poussaint, T. Y.
Children’s Hospital Boston
Boston, MA

**PURPOSE**
Diffusion tensor imaging (DTI) has been used to visualize white matter tracts in brainstem glioma patients (1). The purpose of this study was to assess the major brainstem white matter tracts in children with brainstem glioma before, during and after treatment.

**MATERIALS & METHODS**
A retrospective review of two newly diagnosed brainstem glioma treatment protocols (radiation followed by drug therapy) was done to identify patients who had diffusion tensor imaging over time. Echoplanar diffusion images were obtained on 1.5 T MR scanners. Fractional anisotropy (FA), apparent diffusion coefficient (ADC) and RGB-orientation color maps were created using software created for this purpose using IDL (ITT Visual Information Solutions, Boulder, CO). Regions of interest were placed in bilateral regions of the medial lemnisci, anterior and posterior transverse pontine fibers and corticospinal tracts at the level of the middle cerebellar peduncles and tracts assessed for edema, displacement, infiltration or disruption. Apparent diffusion coefficient, FA and the three eigenvalues were recorded and compared to age-matched controls. Tumor volume was assessed on FLAIR and on postgadolinium T1 images for the presence of enhancement and necrosis.

**RESULTS**
Five patients with brainstem glioma DTI data are described. For all tumors before therapy, the ADC was increased and the fractional anisotropy decreased within the white matter tracts. After radiation therapy, ADC dropped and progressively increased with recurrence. In three patients, there was posterior displacement of the medial lemniscus and anterior transverse pontine fibers with infiltration of the corticospinal tracts and posterior transverse pontine fibers at presentation. After radiation therapy, there was resolution of the posterior displacement in the medial lemniscus in all patients and improvement in the pattern of infiltration in the corticospinal tracts and transverse pontine fibers in all patients, with resolution in one. In two patients with tumoral necrosis at baseline, there was disruption of the corticospinal tracts and posterior transverse pontine fibers and posterior displacement of the medial lemnisci at presentation. In the first patient with necrosis, there was minimal improvement after radiation but with subsequent tumor progression and resultant necrosis, complete disruption of corticospinal tracts was observed. In the second patient with necrosis after radiation there was mild improvement in visualization of the transverse pontine fibers and one corticospinal tract.

**CONCLUSION**
This series demonstrates the value of sequential DTI imaging over time in a BSG clinical trial. Although the numbers of patients in this cohort are small, we found that radiation led to restoration of white matter tracts initially infiltrated. The presence of necrosis was associated with white matter tract disruption in the corticospinal and posterior transverse pontine fibers. A larger in-depth DTI study over time in a larger cohort of brainstem glioma patients may determine if these findings correlate with time to progression or outcome.

**REFERENCES**

**KEY WORDS:** Pediatric, brainstem glioma, diffusion tensor imaging

**Paper 118 Starting at 3:54 PM, Ending at 4:02 PM**

**Serial Susceptibility-Weighted Imaging Suggests Increasing Oxygenation of Tumor Tissue in Children with Diffuse Pontine Glioma Treated with Combined Radiation and Antiangiogenic Therapy**

Patai, Z. · Deistung, A. · Laningham, F. · Loeffler, R. B. · Broniscer, A. · Kun, L. · Reichenbach, J. R. · Hillenbrand, C. M.

1. St. Jude Children’s Research Hospital, Memphis, TN, 2. Friedrich-Schiller University, Jena, GERMANY

**PURPOSE**
Vascular endothelial growth factor (VEGF) is a physiologic signaling protein involved in vasculogenesis (de novo embryonal blood vessel formation) and angiogenesis (new blood vessel formation from existing vasculature) the latter is a key condition of tumor development. Recently developed anti-VEGF drugs (monoclonal VEGF antibodies or antibody derivate) inhibit angiogenesis. This presumably reduces blood supply, impairs metabolism in tumor tissue and ultimately prevents further tumor growth. Decreasing blood perfusion influences tumor tissue oxygenation this aspect of anti-VEGF treatment has not been fully elucidated. Recently introduced susceptibility-weighted imaging (SWI) technique is believed to have the potential to provide indirect information on tissue oxygenation levels in normal and pathologic conditions through its unique ability to generate detectable contrast between normal and hypoxic brain tissue, based on T2* and magnetic susceptibility differences between diamagnetic oxyhemoglobin and paramagnetic deoxyhemoglobin. Since one of the novel therapeutic approaches to pediatric diffuse brainstem gliomas consists of anti-VEGF drug administration (in combination with radiation therapy), such data may shed light on the mechanism of therapeutical effect of anti-VEGF drugs in diffuse brainstem gliomas, but through that perhaps in other malignancies too. In this study, using a blood oxygenation level dependent (BOLD) SWI sequence, we tried to get preliminary data in order to determine if this technique has the potential to be used as an early noninvasive marker of response to treatment.
RESULTS

High-grade tumors tend to have lower ADC values than low-grade tumors. Although the initial results evaluating this methodology in pediatric tumors of the posterior fossa were promising, however there is an overlap in the ADC values of many of these tumors, with some of the high-grade tumors demonstrating restricted diffusion, however sometimes these tumors will show normal or even increased diffusion in comparison to normal values of white matter. None of the low-grade tumors demonstrate decreased ADC values.

CONCLUSION

Apparent diffusion coefficient value can be helpful in differentiating high-grade from low-grade neoplasms, such as rhabdoid/teratoid, medulloblastoma and ependymoma vs astrocytoma. However, there is an overlap in this value when evaluating some of the high-grade tumors, creating some limitations in its use in differentiating rhabdoid/teratoid, medulloblastoma vs ependymoma.

KEY WORDS: Pediatric, neoplasm, ADC maps

Paper 120 Starting at 4:10 PM, Ending at 4:18 PM

Combined MR Imaging and MR Spectroscopy Provides more Accurate Pretherapeutic Diagnoses of Pediatric Brain Tumors than MR Imaging Alone

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1Childrens Hospital Los Angeles, Los Angeles, CA, 2Primary Children’s Medical Center, Salt Lake City, UT, 1Rudi Schulte Research Institute, Santa Barbara, CA

PURPOSE

To demonstrate whether the combination of MR imaging (MRI) with MR spectroscopy (MRS) improved the diagnostic accuracy of untreated pediatric brain tumors over that of MRI alone.

MATERIALS & METHODS

Final imaging reports of 122 consecutive pediatric patients with newly detected brain tumors were reviewed retrospectively. Tumors were subsequently biopsied or resected and final pathology was available in all cases. For group A, comprising of 60 subjects studied between June 2001 - January 2005, radiologists utilized only conventional MRI to arrive at a diagnosis. For group B, comprising of 62 subjects studied between January 2005 - November 2007, the diagnosis was determined after reviewing both MRI and MRS. Both radiologists and a spectroscopist were involved in the interpretation of the group B studies. Comparing with the final histopathologic findings, each imaging diagnosis then was determined to be either a) correct (only diagnosis given or most likely diagnosis in differential diagnosis), b) partially correct (included in differential diagnosis, but not as most likely), or c) wrong. Fisher’s exact test was used to determine if there was a significant difference in diagnostic accuracy between the two groups.

RESULTS

In group A (MRI only), the diagnosis was correct in 63% of patients (38/60), partially correct in 10% of patients (6/60), and incorrect in 27% of patients (16/60). In group B...
(MRI/MRS), the diagnosis was correct in 87% of patients (54/62), partially correct in 5% of patients (3/62) and incorrect in 8% of patients (5/62). The difference in diagnostic accuracy between the two groups was statistically significant (p < 0.01).

**CONCLUSION**

The addition of MRS with conventional MRI significantly improves diagnostic accuracy in preoperative pediatric patients with untreated brain tumors.

**KEY WORDS:** Pediatric brain tumor, MR spectroscopy

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**Paper 121 Starting at 4:18 PM, Ending at 4:26 PM**

**MR Imaging, Spectroscopy, Diffusion and Perfusion in Pilocytic Astrocytoma: A Low-Grade Tumor which Can Sometimes Simulate Features of a Malignant Glioma**

Aragao, M.1,2 · Pelaez, M.1 · Shliominsky, A.1 · Bab, J.1 · Ando, K.1 · Devillers, L.1 · Fatterpekar, G.1 · Delman, B.2 · Leeds, N.1 · Fowkes, M.1 · Naidich, T.1 · Law, M.1

1Mount Sinai Medical Center, New York, NY, 2Multimagem Hospital Albert Sabin, Recife, BRAZIL, 3New York University, New York NY

**PURPOSE**

Pilocytic astrocytoma (PA) is the most common pediatric central nervous system glioma and pediatric cerebellar tumor. Although it is classified as a WHO Grade I glioma because of its benign biologic behavior, this tumor may present with imaging and histopathologic features sometimes suggestive of a more malignant tumor. The purpose of this study is to review the magnetic resonance imaging (MRI), diffusion, multivoxel spectroscopy (MRS) and perfusion [relative cerebral blood volume (rCBV)] findings of PA compared with high-grade gliomas (HGG).

**MATERIALS & METHODS**

MR imaging of 18 patients with PA and 22 patients with HGG without treatment were studied. All patients had histopathologic confirmation (WHO Classification) of PA (Grade I) and HGG (WHO III-IV). MR imaging was performed at 1.5 T, ADC values were calculated from diffusion-weighted imaging (DWI) with b=1000. Perfusion imaging using a first pass, dynamic susceptibility contrast perfusion MRI sequence was used to derive relative cerebral blood volume measurements (rCBV). Multivoxel MRS was done with TR/TE=1.500/35 ms. The volume of interest included the tumor and normal contralateral brain. The NAA/Cr, Cho/Cr, Cho/NAA, ratios were calculated.

**RESULTS**

Within the PA group there were 9/18 (50%) solid and 9/18 (50%) solid-cystic. Of the HGG, 12/22 (54%) were necrotic and 10/22 (46%) were solid. Within the PA group: 1/18 (6%) did not enhance; 7/18 (38.8%) demonstrated homogeneous enhancement, 6/18 (33%) demonstrated heterogeneous enhancement and 4/18 (22.2%) demonstrated ring enhancement. Of the HGG: 2/22 (9%) did not enhance; 1/22 (4.5%) demonstrated homogeneous enhancement, 7/22 (31.8%) demonstrated heterogeneous enhancement and 12/22 (54.5%) demonstrated ring enhancement. The DWI in the PA group demonstrated a mean ADC and standard deviation (SD) 1.6 x 10⁻³ mm²/sec ± 0.4 and for HGG the ADC was 1.4 x 10⁻³ mm²/sec ± 0.7 (p = 0.3). The mean rCBV ± SD for the PA group was 1.4 ± 0.8 versus 3.3 ± 1.4, for the HGG, with a statistically significant difference (P < 0.005). There were two PA (2/18) with markedly elevated perfusion rCBV > 1.75. For MR spectroscopy in PA, the mean ± SD was 1.3 ± 0.7 for NAA/Cr and 1.9 ± 1.0 for Cho/NAA, but two patients with lesions located in the hypothalamus demonstrated NAA/Cr ratios < 1 and Cho/NAA > 2.6. In the HGG group, the mean ± SD for NAA/Cr = 1.12 ± 0.57, Cho/NAA = 1.42 ± 0.88, Cho/Cr = 2.97±1.85. There was not a statistically significant difference in metabolite ratios between PA and HGG.

**CONCLUSION**

There was a statistically significant difference in rCBV/perfusion between HGG and PA, there were a number of PAs which demonstrated markedly elevated rCBV. In terms of enhancement, PAs demonstrated solid-cystic and homogeneous enhancement more frequently whereas HGGs were more likely to demonstrate ring enhancement. Finally, even though sometimes the imaging findings of PA may suggest a more malignant tumor, the age of the patient (frequently less than 20 years old) would be more suggestive of PA, so that the age, the radiographic and pathologic findings must be considered together when making the final diagnosis.

**KEY WORDS:** Pilocytic astrocytoma, high-grade tumors, advanced MRI

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**Paper 122 Starting at 4:26 PM, Ending at 4:34 PM**

**Infantile Hemangiomas with Intracranial or Intraspinal Manifestation: Prevalence, Imaging Characteristics, and Clinical Significance**

Viswanathan, V.1 · Smith, E. R.2 · Kozakewich, H.3 · Orbach, D. B.2,1

1Brigham and Women’s Hospital, Boston, MA, 2Children’s Hospital Boston, Boston, MA

**PURPOSE**

Infantile hemangiomas, highly prevalent benign tumors of endothelial origin, have been well characterized on the basis of imaging and histopathologic features. These lesions typically present within the first few weeks of life and undergo a rapid proliferative stage followed by a protracted involutional stage. To date, fewer than five case reports of true infantile hemangiomas within the central nervous system have been published. We systematically reviewed the data base of the Vascular Anomalies Center at Children’s Hospital Boston to assess the prevalence of this unusual presentation of infantile hemangioma.

**MATERIALS & METHODS**

We retrospectively reviewed our data base since 1999 to identify patients who had documented hemangiomas with intracranial or intraspinal manifestation and describe their imaging characteristics. Clinical and histopathologic follow up was obtained where available.

**RESULTS**

Of 1451 patients with hemangioma, we identified 12 (0.8%) who had either intracranial or intraspinal manifestation. In most cases, direct extension of an extracranial or extraspinal...
lesion could be documented; in other cases, a surface heman-
gioma was superficial to a CNS lesion with identical imag-
ing characteristics, but direct contiguity could not be visual-
ized. We identified seven patients with intracranial heman-
gioma, four patients with intraspinal hemangioma, and one
patient with both. Five patients demonstrated regression of
the CNS lesions on imaging, one patient had pathologically
proved hemangioma, and another patient had both pathology
and follow-up imaging regression documented. One patient
developed dural sinus thrombosis and three developed
hydrocephalus. None of the 12 patients demonstrated any
abnormal adjacent brain or spinal parenchymal signal abnor-
malities.

**Conclusion**

Intracranial or intraspinal extension of infantile heman-
giomas is an unusual but important finding that may alter
patient management. While these benign neoplasms are not
associated with cerebral or spinal parenchymal signal abnor-
malities, they may contribute to increased patient morbidity,
including hydrocephalus and dural venous sinus thrombosis.

**Key Words:** Hemangioma, intracranial, infantile

**Paper 123 Starting at 4:34 PM, Ending at 4:39 PM**

**Generalized Infantile Myofibromatosis with Extensive
Intraparenchymal Involvement**

Robinette, N. L. · Parmar, H. · Ruiz, R. E. · Roulston, D. ·
Campbell, A.

University of Michigan Health System
Ann Arbor, MI

**Purpose**

To report a unique case of biopsy proved infantile myofi-
bromatosis (IM) presenting at birth with left lower extremity,
left intraocular and numerous paraspinal and intraparenchymal masses with subsequent dramatic response
to systemic chemotherapy.

**Case Report**

A full term infant at delivery was noted to have extensive
bluish cutaneous lesions involving the entire body and an
enlarged dysmorphic left lower extremity. Physical examina-
tion further revealed clouding of the left iris and lack of red
light reflex. At 8 days of life an open biopsy of the left thigh
mass revealed histopathology and immunohistochemistry
consistent with myofibroma. The patient’s karyotype, mosaic
female 48,XX,+7,+8, is also suggestive of myofibromatosis.

**Imaging Findings**

MR imaging of the pelvis and left lower extremity revealed
several enhancing masses within the left posterior thigh and
left gluteus maximus which extended into the pelvis with
multilevel neural foraminal and left psoas muscle invasion.
Computerized tomographic imaging of the orbit and MRI of
the head demonstrated solitary homogenously enhancing
lesions in the medial left globe, pineal gland, infundibular
stalk and left temporoparietal lobe. Numerous larger
homogenously enhancing lesions also were identified within
the cerebellar hemispheres. Follow-up MRI after 4
months of chemotherapy demonstrated complete resolution
of the left ocular, pineal gland, pituitary infundibular and left
temporoparietal lesions with significant decrease in size of
the cerebellar and paraspinal lesions.

**Summary**

Infantile myofibromatosis is the most common fibrous
tumor of infancy and early childhood. The typical presenta-
tion of IM is characterized by firm fibrous nodules of spin-
dle-shaped cells localized to the dermis, subcutaneous tissue
and soft tissues. A review of literature reveals several report-
ed cases of intracranial involvement associated with IM; however, the majority of reported cases demonstrate purely
extraaxial lesions. Intracranial and specifically, intraparenchymal involvement is extremely rare in myofibro-
matosis, with only one reported case in the literature. To our
knowledge, the extensive intraparenchymal involvement,
within both supra and infratentorial compartments, demon-
strated in our patient has not been reported previously.
Furthermore, the dramatic response to systemic chemothera-
py and unusual karyotype is also noteworthy.

**Key Words:** Infantile myofibromatosis, intracranial myofi-
bromatosis, intraparenchymal myofibromatosis

**Paper 124 Starting at 4:39 PM, Ending at 4:44 PM**

**Inflammatory Myofibroblastic Tumor with Extensive
Orbital, Paranasal Sinus, Intracranial, and Systemic
Skeletal Involvements**

Moritani, T. · Kirby, P. · Greenlee, J. D. W. · Sato, Y.

University of Iowa Hospitals and Clinics
Iowa City, IA

**Purpose**

Inflammatory myofibroblastic tumor (IMT), Tolosa-Hunt
syndrome, and idiopathic hypertrophic pachymeningitis are
a spectrum of disorders with diverse imaging appearances
with similar histologic findings. We report a case of IMT
with extensive orbital, paranasal sinus, intracranial, and sys-
temic skeletal involvements.

**Case Report**

An 8-year-old boy had progressive proptosis, esotropia and
headache. No known past or family history.

**Imaging Findings**

Orbital CT showed homogenously enhancing mass lesions in
bilateral extraocular muscles, maxillary sinuses, cavernous
sinuses and pituitary gland. Extensive osteosclerotic changes
and bone thickening in the facial bones and skull base also
were noted. MR imaging revealed T1 iso-, T2 low-signal-intensity and homogenously enhancing lesions in the orbits, maxillary sinuses, cavernous sinuses, pituitary gland, pineal gland, brain stem and cerebellum. Skeletal survey and subsequent FDG-PET showed systemic bone involvement as well. Orbital and paranasal sinus biopsy revealed dense sclerotic connective tissue with lymphocyte and macrophage infiltration consistent with IMT. The patient’s symptom was improved with steroid therapy.

**SUMMARY**

We report a case of inflammatory myofibroblastic tumor with extensive orbital, paranasal sinus, intracranial and systemic skeletal involvements.

**KEY WORDS:** Inflammatory myofibroblastic tumor, MRI, CT
CONCLUSION
We report a case of papillary tumor of the pineal region (PTPR).

KEY WORDS: Papillary tumor, pineal gland, Indium-111 octreotide

Paper 126 Starting at 4:49 PM, Ending at 4:57 PM
Usefulness of 4 Dimensional CT of Brain Tumors and a Comparison with Digital Subtraction Angiography

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1Akita University School of Medicine, Akita, JAPAN, 2GE Healthcare, Tokyo, JAPAN

PURPOSE
Dynamic (time-resolved) 3D CT angiography (4D CT) has been developed recently and applied to imaging intracranial neoplasms and compared with conventional intraarterial digital-subtraction angiography (IADSA). The usefulness and limitations of this technique are discussed.

MATERIALS & METHODS
Eighteen patients (11 men, 7 women) with intracranial neoplasms were investigated using 4D CT. The age ranged from 18 to 78 years. Underlying pathology comprised anaplastic oligodendroglioma (n = 4), meningioma (n = 4), glioblastoma (n = 3), astrocytoma, oligodendroglioma, craniopharyngioma, hemangioblastoma, malignant lymphoma, medulloblastoma and malignant meningioma (n = 1 each). CT was performed using a multidetector row CT (MDCT) scanner with 64 detectors. Dynamic scanning was started 10 s after injection of contrast medium. Using a power injector, 50 mL of nonionic contrast medium was injected at a rate of 4 mL/s, followed by bolus injection of 40 mL saline. A pressure monitor on the power injector was used to prevent catheter rupture and extravasation. Scan parameters were 135 kV/150 mA, 1.0 s/rotation, 512×512 matrix, 64 sections of 0.625 mm, and scan range of 40 mm. To acquire 4D CT images, CT data were transferred to a workstation networked to the MDCT. Original CT data were rearranged at each time phase. Serial volume-rendering (VR) images were displayed in cine mode. Intraarterial digital-subtraction angiography was performed in 10 of 18 cases, and 4D CT was compared with IADSA in the visualization of tumor vessels and staining, feeding arteries and early venous filling.

RESULTS
In all 18 cases, 4D CT was achieved successfully. All 4D CT results could be displayed as cine movies. Static 3D images also were acquired in arbitrary directions. Time-resolved 2D images could be shown. Precise information on anatomical relationships between tumor and surrounding vessels could be acquired. In addition, 4D CT indicated hemodynamics within the tumor and surrounding tissues. Intraarterial digital-subtraction angiography showed tumor vessels/staining in 10 cases, feeding arteries in eight cases and early venous filling in five cases. In comparison, 4D CT showed tumor vessels/staining in six cases, feeding arteries in six cases and early venous filling in four cases. Early venous filling was seen for glioblastomas or hemangioblastoma. Limitations of this technique include a relatively high radiation dose and limited scan range (40 mm). In the 10 patients who did not undergo IADSA, 4D CT also demonstrated tumor vessels/staining, feeding arteries and early venous filling.

CONCLUSION
This new technique can provide both spatial and temporal information on tumors and surrounding tissues. Less invasive than IADSA, 4D CT can depict dynamic patterns of tumor vessels and staining that can be shown by IADSA, and may replace IADSA in diagnosis and preoperative assessment for patients with brain tumors.

KEY WORDS: 4D CT, brain tumors

Monday Afternoon
3:30 PM – 5:00 PM
Room 204/205

(13) ELC Workshop A: Introduction to PowerPoint

(127) Introduction to PowerPoint
— John L. Go, MD
Monday Afternoon

5:00 PM – 6:30 PM
La Louisiane Ballroom

(14) Advances in Neuroscience Using NMR Genes, Brain and Behavior

(128) The Pediatric Skull Base
— Gary L. Hedlund, DO

(129) The Patient Presenting with a Motor Cranial Neuropathy
— Wendy R. K. Smoker, MD, FACP

(130) Complex Cranial Neuropathies: The Intersection of Anatomy and Pathology
— Christine M. Glastonbury, MBBS

Moderator: Wendy R. K. Smoker, MD, FACP

The Pediatric Skull Base
Gary L. Hedlund, DO

Dr. Hedlund currently serves as the Chairman of the Department of Medical Imaging at Primary Children’s Medical Center in Salt Lake City, Utah. He is active in the practice of pediatric neuroradiology. He is an adjunct Professor of Radiology at the University of Utah College of Medicine. His Board Certification is in Diagnostic Radiology given by the American Board of Radiology. He has completed fellowships in pediatric radiology and pediatric neuroradiology at the Children’s Hospital Medical Center in Cincinnati.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review pertinent skull base embryology.
2) Recognize normal development of the pediatric skull base.
3) Review the anatomical pitfalls that may mimic disease.
4) Discuss the more common clinically important congenital and acquired disorders of the skull base.
5) Discuss the benefits and limitations of CT and MRI when imaging the pediatric skull base

Presentation Summary
Evaluation and accurate interpretation of abnormalities of the pediatric skull base begins with a foundational knowledge of normal developmental anatomy, and maturational changes that occur with age. In this session, the normal named bones comprising the pediatric skull base, the three anatomical regions comprising the skull base and their boundaries will be explored. Additionally, practical developmental anatomy, maturational changes at varied ages, pitfalls to imaging interpretation and representative pediatric skull base pathology will be reviewed.

The Patient Presenting with a Motor Cranial Neuropathy
Wendy R. K. Smoker, MD, FACP

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Identify the location of the brainstem nucleus and trace the extracranial course for each motor cranial nerve.
2) Identify the muscles innervated by each motor cranial nerve.
3) Identify the various stages of muscle denervation on MR studies.
4) List common causes of denervation for each motor cranial nerve.

Presentation Summary
The ability to visualize most cranial nerves, as well as their exit foramina from the skull, has mandated “relearning” cranial nerve anatomy. Although sequellae resulting from insults to sensory nerves are impossible to demonstrate, denervation atrophic changes, resulting from insults to motor cranial nerves, are typically demonstrable. When denervation changes are identified, it is essential to evaluate the entire course of the nerve back to its brainstem nucleus. Therefore, thorough knowledge of the course of each cranial nerve, as well as muscles innervated by these nerves, is essential. One must also understand and recognize the stages of denervation. Muscles undergoing acute and early subacute denervation are typically ENLARGED and ENHANCE abnormally (not to be mistaken for inflammatory or neoplastic pathology!). Muscle enlargement is thought to be due to enlargement of extracellular spaces and increased tissue water. Abnormal enhancement may be due to increased blood flow within the denervated muscle and/or increased contrast accumulation within enlarged extracellular spaces. As denervation progresses to the early and late chronic stages, fatty infiltration and muscle atrophy predominate. This presentation reviews the anatomy of the motor cranial nerves, the muscles innervated by each of these nerves, and demonstrates various patterns and stages of denervation atrophy involving each of the nerves. Typical causative pathologies are also demonstrated.
Complex Cranial Neuropathies: The Intersection of Anatomy and Pathology
Christine M. Glastonbury, MBBS

Dr. Glastonbury is Associate Professor of Clinical Radiology at the University of California, San Francisco (UCSF) in the department of Neuroradiology. Her subspecialty focus is in Head and Neck imaging with particular interest in the imaging of H&N tumors and of hearing loss. Dr Glastonbury is Assistant Director of the Neuroradiology Fellowship program at UCSF and Chief of Neuroradiology at the UCSF Mount Zion and VA Medical Center campuses.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Identify cranial nerve (CN) anatomy and function.
2) Emphasize the importance of dedicated techniques for CN imaging.
3) Illustrate the complexity of clinical neurologic syndromes involving the CN and how the radiologist can best participate in finding a pathological cause.

Presentation Summary
The key to better imaging and interpretation of cranial neuropathies is a thorough understanding of the normal anatomy of each cranial nerve (CN). Frequently, however, cranial neuropathies do not present as isolated abnormalities but as multiple cranial neuropathies. An understanding of the anatomical “intersection” points of CN either intra or extracranial is therefore very important for 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, with which the referring clinician may be very familiar. 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 may also 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 pathological cause. The key to better imaging and interpretation of cranial neuropathies is a thorough understanding of the normal anatomy of the cranial nerves. A clinical history of more than one CN abnormality can often pinpoint the main region of concern within the brain or the head and neck to allow a more focused exam and more accurate interpretation.

Monday Afternoon
5:00 PM – 6:00 PM
Room 206/207

(15) ASPNR Programming: Neurocardiology – The Heart and Brain Connection

(131) Genetics of White Matter Disorder - Cardiomyopathy and Mitochondrial Cytopathy
— Fernando Scaglia, MD

(132) Neuroimaging of Mitochondrial Cytopathy/Pediatric Stroke
— Jill V. Hunter, MD

(133) Outcomes of Complex Congenital Heart Disease
— Ashok Panigrahy, MD

Moderator: W. K. “Kling” Chong, MD, FACR

Genetics of White Matter Disorder - Cardiomyopathy and Mitochondrial Cytopathy
Fernando Scaglia, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Discuss the wide spectrum of presenting features and clinical outcomes in mitochondrial cytopathies.
2) Recognize the prevalence of posterior fossa involvement in subjects with mitochondrial cytopathies.
3) Review the different molecular mechanisms of pediatric mitochondrial encephalomyopathies.

Presentation Summary
Mitochondrial cytopathies are clinical syndromes associated with abnormalities of oxidative phosphorylation. These conditions have a minimal established incidence of 1 in 10,000 births and likely to be greater. We performed a retrospective review of the medical records of 400 patients who were referred for evaluation of mitochondrial disease to elucidate the frequency of major clinical manifestations in children with mitochondrial disease and establish their clinical course, prognosis, and rates of survival depending on their
clinical features. By use of the modified Walker criteria, only patients who were assigned a definite diagnosis were included in the study. A total of 113 pediatric patients with mitochondrial disease were identified. A total of 102 (90%) patients underwent a muscle biopsy as part of the diagnostic workup. A significant respiratory chain (RC) defect was found in 71% of the patients who were evaluated. In this cohort, complex I deficiency (32%) and combined complex I, III, and IV deficiencies (26%) were the most common causes of RC defects, followed by complex IV (19%), complex III (16%), and complex II deficiencies (7%). Pathogenic mitochondrial DNA abnormalities were found in 11.5% of the patients. A substantial fraction (40%) of patients with mitochondrial disorders exhibited cardiac disease, diagnosed by Doppler echocardiography; however, the majority (60%) of patients had predominant neuromuscular manifestations. No correlation between the type of RC defect and the clinical presentation was observed. Overall, the mean age at presentation was 40 months. However, the mean age at presentation was 33 months in the cardiac group and 44 months in the noncardiac group. Twenty-six (58%) patients in the cardiac group exhibited hypertrophic cardiomyopathy, 29% had dilated cardiomyopathy, and the remainder (13%) had left ventricular noncompaction. Patients with cardiomyopathy had an 18% survival rate at 16 years of age. Patients with neuromuscular features but no cardiomyopathy had a 95% survival at the same age. In addition, we identified a substantial number of patients with definite mitochondrial encephalopathies who exhibit predominant or isolated posterior fossa involvement with either progressive cerebellar atrophy or cerebellar hypoplasia. This study gives strong support to the view that in patients with RC defects, cardiomyopathy is more common than previously thought and tends to follow a different and more severe clinical course. Although with a greater frequency than previously reported, mitochondrial DNA mutations were found in a minority of patients, emphasizing that most pediatric mitochondrial disorders follow a Mendelian pattern of inheritance.

Outcomes of Complex Congenital Heart Disease
Ashok Panigrahy, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Illustrate advances in MR imaging, including diffusion tensor imaging and MR spectroscopy in the detection and characterization of brain injury in neonates with complex congenital heart disease.
2) Demonstrate that term infants with congenital heart disease are at risk for white matter injury similar to premature infants.
3) Review the neurodevelopmental outcomes in neonates with congenital heart disease which is multifactorial, likely related to a combination of fixed and modifiable factors.

PRESENTATION SUMMARY
Congenital heart disease (CHD) is a common cause of childhood morbidity occurring in 6-8/1000 live births, with up to 50% of children requiring open-heart surgery to correct the defect. Advances in cardiac surgery over the last two decades have facilitated the repair of complex CHD in younger patients, particularly in the neonatal period. As surgical and support techniques improve, attention is increasing focused upon the neurologic outcome of survivors and the prevention of hypoxic-ischemic brain injury that may result in life-long cognitive problems, seizures and cerebral palsy. Follow-up studies of complex CHD infants undergoing cardiac surgery indicated that as many as 25% of survivors have developmental and neurologic abnormalities. Neuropathologic studies of both term and preterm infants dying after cardiac surgery demonstrate a large incidence of cerebral white matter damage (periventricular leukomalacia and white matter gliosis) (1). Advances in neonatal neuroimaging have improved the ability to detect brain injury in neonates with complex CHD, including stroke and white matter injury (2,3). Both diffusion tensor imaging and MR spectroscopy have been used to detect abnormal brain development and brain injury in neonates with complex CHD (2,3). More than a third of newborns with CHD have brain injuries noted on MRI prior to cardiac surgery, with an additional third of newborns acquiring brain injury during or shortly after cardiac surgery. Multiple factors influence neurodevelopmental outcome in neonates with complex CHD (4). Fixed factors include genetic predisposition and abnormal in utero brain development. Modifiable factors include intraoperative variables (cardiopulmonary bypass, deep hypothermic circulatory arrest and hemodilution) and peri-operative variables including hypoxemia, hypotension and low cardiac output. A combination of fixed and modifiable factors likely influence neurodevelopmental outcome in neonates with complex CHD (3). Future work is aimed at (1) improving our understanding of brain development in utero; (2) clinical trials of neu-

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Neuroimaging of Mitochondrial Cytopathy/Pediatric Stroke
Jill V. Hunter, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Recognize the entity of pediatric stroke and how the etiology differs from adult stroke.
2) Illustrate the patterns of presentation of pediatric stroke.
3) Discuss the heart-brain connection in terms of channelopathies.

PRESENTATION SUMMARY
The etiologies of pediatric stroke are very different from those of adult stroke. Atherosclerosis is a rare cause of stroke in childhood while hematologic and cardiac etiologies are much more prevalent. Stroke in childhood can be divided into arterial ischemic stroke, hemorrhagic stroke and dural venous sinus thrombosis. Pediatric stroke remains an under-diagnosed problem that may have significant long-term economic implications. Treatment of childhood stroke remains problematic as there have been few well controlled clinical trials to date and it is not clear that adult therapies translate to the pediatric population. This talk will review the use of neuroimaging in the diagnosis and management of the diverse etiologies of pediatric stroke and their implications for therapy.
roprotection; (3) improved peri- and intraoperative monitor-
ing and (4) and better strategies to treat long term complex
CHD survivors with neurodevelopmental disabilities.

REFERENCES
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2. Panigrahy A, Bluml S. Advances in magnetic resonance neu-
   roimaging techniques in the evaluation of neonatal encepha-
3. Miller SP, McQuillen PS et al. Abnormal brain development
4. Ballweg JA, Wernovsky G et al. Neurodevelopmental out-
   comes following congenital heart surgery. Ped Cardiol
   2007;28:126-133

Monday Afternoon
5:00 PM – 6:30 PM
Room 208/209

(16) Advanced Imaging Seminar –
Diffusion Tensor Imaging

(134) DTI: Advanced Clinical Applications
   — Aaron S. Field, MD, PhD

(135) MRI of Connectional Neuroanatomy
   — Van J. Wedeen, MD, PhD

(136) High Field Spinal Cord DTI
   — Eric D. Schwartz, MD

Moderators: Timothy P. L. Roberts, PhD
            Howard A. Rowley, MD

DTI: Advanced Clinical Applications
Aaron S. Field, MD, PhD

PRESENTATION SUMMARY
Water molecules in white matter diffuse most readily paral-
lel to neuronal fascicles. This anisotropic pattern of diffusion
is detected with diffusion-sensitizing gradients during MRI,
typically modeled as a tensor (3D ellipsoid) at every voxel
and visualized using gray-scale maps of diffusion anisotropy
or color maps depicting fiber orientation. Mathematical
algorithms are used to generate computer graphical repre-
sentations of fiber tracts in 3D; these tractograms can be dis-
played in a variety of ways. Broadly categorized, clinical
applications of DTI tractography include: tissue characteri-
zation, lesion localization and tract mapping per se. Problems of tissue characterization typically are 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 often 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 the disease process with the neurologic presenta-
tion. Although tractography can yield such quantitative
measures as connectivity (the strength or likelihood of any
functional connection between cortical or subcortical struc-
tures) or fiber density (the number of trajectories identified
per voxel in a region of interest), the technique is used pri-
marily as a visualization tool in the clinical setting. For
example, DTI tractography is suited uniquely to depict the
development 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 sen-
sitive to image noise and assorted artifacts that can reduce
the accuracy of tract mappings. The tensor model is 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. This presentation will
provide a brief review of DTI principles followed by an
overview of the common applications currently (or likely
soon to be) in clinical use as well as some of the pitfalls that
may be encountered in clinical applications.

MRI of Connectional Neuroanatomy
Van J. Wedeen, MD, PhD

High Field Spinal Cord DTI
Eric D. Schwartz, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be
able to:
1) Review literature regarding high field DTI of the spinal
cord.
2) Discuss strategies to implement spinal cord DTI in the
   clinical setting.

PRESENTATION SUMMARY
In this lecture, we will review the use of diffusion tensor
imaging (DTI) at high field both experimentally and clini-
cally. The technical challenges and possible solutions to
applying this technique to the clinical setting, including problems related to susceptibility and spinal cord motion, will be reviewed. We will review the current literature and see how this technique has been applied to spinal cord diseases.

REFERENCES

Monday Afternoon

5:00 PM – 6:30 PM
Room 204/205

(17) ELC Workshop C: Advanced PowerPoint

(137) Advanced PowerPoint

— Barton F. Branstetter IV, MD
### Tuesday Morning

**7:45 AM - 8:45 AM**

*La Louisiane Ballroom*

(18) Maintenance of Certification (MOC) - ENT and Adult Spine Review Session

**Audience Response Plus+ (AR+)**

- (138) ENT
  
  — Christine M. Glastonbury, MBBS

- (139) Adult Spine
  
  — Carl E. Johnson, MD

Moderator: Christine M. Glastonbury, MBBS

*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.

### Tuesday Morning

**8:45 AM - 10:15 AM**

*La Louisiane Ballroom*

(19) General Session: Minor Head Trauma

- (140) Neuropsychologic Deficits and Testing Including fMRI
  
  — Bruce McCandliss, PhD

- (141) DWI DTI MEG Perfusion
  
  — Pratik Mukherjee, MD, PhD

- (142) Clinical Findings and Sports Related Injury
  
  — Barry D. Jordan, MD, MPH

Moderator: Pratik Mukherjee, MD, PhD

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**LEARNING OBJECTIVES**

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

1. Analyze adult spine CT and MR imaging studies in common and uncommon disorders presented as unknown cases.
2. Formulate a limited differential diagnosis based upon the imaging and clinical findings.

**PRESENTATION SUMMARY**

In this maintenance of certificate review session unknown CT or MR adult spine cases will be shown to review pertinent imaging and clinical findings that may be encountered in evaluation of the adult spine. The presented cases will include a gamut of both common and uncommon disorders and/or clinical presentations. Multiple choice questions will be provided utilizing the audience response system to provide an interactive review of the cases. The imaging and clinical findings and limited differential considerations will be discussed with the goal to improve understanding of common or unusual imaging appearances of adult spine disorders.
Neuropsychologic Deficits and Testing Including fMRI
Bruce McCandliss, PhD

Dr. McCandliss is an Associate Professor at the Weill Cornell Medical College in New York, NY. He has extensive expertise in neuroimaging, specifically in functional fMRI and DTI imaging, and its applications to studying normal cognitive function, normal development and developmental disabilities, and mild TBI. He holds a PhD in cognitive psychology, with substantial expertise in the areas of attention, language (including speech perception and reading development), and memory. His work is currently funded by federal grants from the NIH, NSF, as well as grants from the J.S. McDonnell Foundation. He is also the recipient of the 2006 Presidential Early Career Award in Science and Engineering and the John Merck Fund Scholar Award.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the underlying physics of Diffusion Tensor Imaging and Fractional Anisotropy.
2) Identify the three anatomical properties of white matter tracts that influence these measures, as well as the limitations regarding direct inferences about anatomy from DTI-FA data.
3) Discuss how cognitive function is quantified in subsystems of attention, language, and memory.
4) Review the potential role of DTI-FA images in investigating structure function relationships between distinct white matter pathways and distinct cognitive functions.

PRESENTATION SUMMARY
Diffusion Tensor Imaging of microstructural properties of white matter tracts can be used to quantify fractional anisotropy (FA) in several brain regions using a semi-automated Reproducible Objective Quantification Scheme (ROQS) technique. Such measures, related to the degree of coherence, density, and myelination of a tract, are correlated with cognitive performance in normal and patient populations. This talk will review recent research relating variation in FA within specific white matter tracts to variation in quantitative performance within specific sub-systems of three major cognitive domains: attention, memory, and language. Across these domains, this talk will demonstrate highly tract specific to domain specific brain-behavior correlations in normal adults and children, and that these continuous relationships in the normal population can be extrapolated to predict the specific cognitive impairments implicated by loss of FA in specific tracts associated with mild traumatic brain injury and developmental dyslexia.

DWI DTI MEG Perfusion
Pratik Mukherjee, MD, PhD

LEARNING OBJECTIVES:
Upon completion of this presentation, participants will be able to:
1) Illustrate advances in neuroimaging, including diffusion-weighted imaging (DWI), diffusion tensor imaging (DTI), and magnetoencephalography (MEG) for the detection and characterization of mild traumatic brain injury (TBI)

PRESENTATION SUMMARY
Current neuroimaging methods such as head computed tomography (CT) and conventional magnetic resonance (MR) imaging often are unrevealing in cases of mild traumatic brain injury (TBI), despite long-term cognitive and behavioral impairments suffered by the patients that include deficits in concentration and short-term memory. In this presentation, promising new approaches to detecting and characterizing mild TBI will be discussed, including studies of microstructural white matter integrity and connectivity using diffusion tensor imaging (DTI) and of functional connectivity among brain regions using magnetoencephalography (MEG). Recent data regarding the advantages of these new methods and their significance to the neurocognitive outcome of mild TBI patients will be introduced.

Clinical Findings and Sports Related Injury
Barry D. Johnson, MD, MPH

Dr. Jordan is a neurologist with specialized interests in traumatic brain injury, sports neurology, and Alzheimer disease. Currently, Dr. Jordan serves as the Director of the Brain Injury Program and the Memory Evaluation and Treatment Service (METS) at the Burke Rehabilitation Hospital in White Plains, New York. Dr. Jordan is also the Chief Medical Officer of the New York State Athletic Commission and is an Associate Professor of Clinical Neurology at Weill Medical College of Cornell University. Dr. Jordan graduated from the University of Pennsylvania with a BA in neurophysiology and obtained his MD degree from Harvard Medical School and his Masters in Public Health from Columbia University.

PRESENTATION SUMMARY
The increased popularity of contact sports world-wide, exposes a large number of participants to both acute and chronic traumatic brain injury. Acute traumatic brain injury (ATBI) represents the immediate manifestations of mechanical forces directly or indirectly impacting the brain. In sports, the cerebral concussion represents the most common ATBI, however more moderate to severe TBI, such as intracranial hemorrhages and cerebral contusions, may infrequently be encountered. The Centers for Disease Control and Prevention estimates that 300,000 sports-related concussions occur annually. A cerebral concussion may or may not be associated with loss of consciousness and essentially is a reversible syndrome without detectable pathology. Cerebral concussions can present with headaches, disorientation/memory deficits, impaired concentration/attention, gross incoordination and dizziness/vertigo. Concussion severity
can be determined only when all symptoms have resolved, the neurologic examination is normal and cognitive function has returned to baseline. The management of concussion should be determined on an individual basis. The athlete should be allowed only to return to competition when he or she is asymptomatic at rest and exertion. Premature return to contact collision sports may predispose the athlete to the second impact syndrome (SIS). The SIS represents a catastrophic and exaggerated neurologic response to a minor head trauma in an athlete who remains symptomatic from a preexisting concussion. The SIS is associated with significant morbidity and mortality. Chronic traumatic brain injury (CTBI) represents the cumulative, long-term neurologic consequences of repetitive concussive and subconcussive blows to the brain. Although this condition has been described primarily in boxing, it may be anticipated in other contact sports such as soccer, football, ice hockey, and the martial arts. Chronic traumatic brain injury can present with motor, cognitive and behavioral manifestations. Conventional neuroimaging is typically nonspecific and may include diffuse atrophy, nonspecific white matter changes, and the presence of a cavum septum pellucidum. Since treatment options in CTBI are relatively limited, the prevention of CTBI is of paramount importance. Minimizing the frequency and severity of ATBI in sport will be instrumental in accomplishing this goal. The prevention of CTBI will need to be sport specific and will undoubtedly rely on limiting the exposure of high-risk athletes, utilizing of protective equipment, enforcing strict rule adherence, training and supervising athletes, and increasing medical surveillance.

Tuesday Morning

10:45 AM – 12:30 PM

La Louisiane Ballroom

(20a) INTERVENTIONAL: Aneurysms I
(Scientific Papers 143 – 155)

See also Parallel Sessions
(20b) ADULT BRAIN: Trauma, Inflammation & Ischemic Disease/Excerpta
(20c) ADULT BRAIN: Functional II
(20d) PEDIATRIC: Functional Imaging

Moderators: Vance E, Watson, MD
Christopher J. Moran, MD

Paper 143 Starting at 10:45 AM, Ending at 10:53 AM

Strategies and Results in the Endovascular Treatment of Intracranial Trunkal (Lateral) Aneurysms

Biondi, A. · Jean, B. · Boch, A. L. · Dormont, D. · Chiras, J. · Van Effenterre, R.
Pitié-Salpêtrière Hospital
Paris, FRANCE

PURPOSE

Aneurysms arising along the arterial trunks are uncommon and not well characterized lesions in contrast to saccular aneurysms arising at arterial bifurcations. According to pathologic studies, most of spontaneous trunkal aneurysms are related to dissecting phenomena. The purpose of our study was to evaluate the strategies and results of the endovascular therapy in trunkal aneurysms.

MATERIALS & METHODS

Retrospective chart analysis and radiologic studies evaluation were carried out in 64 patients with a trunkal intracranial aneurysms treated by endovascular. Both proximal and distal locations were included in this study. On the basis of clinical presentation, aneurysms were separated into acute or chronic lesions. On the basis of imaging findings, aneurysms were separated in thrombosed and nonthrombosed. Endovascular treatment included parent artery occlusion (PAO), selective treatment using coils or coils and stenting. The type of procedure was evaluated in relation to the size (small, large and giant) and the morphology (focal dilatation or fusiform) of the aneurysm.

RESULTS

Trunkal aneurysms presenting acutely (usually with subarachnoid hemorrhage, more rarely with ischemic phenomena) are usually small and nonthrombosed. Because of the high risk of rebleeding and poor prognosis of these aneurysms, endovascular treatment is mandatory. Selective treatment using coils/stent is feasible in many cases. However the PAO is indicated in some instances. “Chronic” trunkal aneurysms with progressive evolution often become symptomatic because of mass effect; they are usually large or giant and thrombosed. These aneurysms usually do not bleed. However, minor bleedings arising from the arterial wall, and not from the vessel lumen, can occur. Because the pathologic process involves the arterial wall, selective treatment usually is ineffective with high rate of aneurysmal recanalization and the PAO remained the best treatment. In some anatomical configurations stent-supported coil embolization was performed with good results and appeared a promising technique. In large aneurysms, the so-called “extension of thrombosis” after selective endovascular occlusion, was observed more frequently in trunkal aneurysms in relation to typical saccular lesions.
CONCLUSION

Careful evaluation and understanding of the underlying pathologic mechanisms of these aneurysms is useful in order to plan the appropriate endovascular treatment.

KEY WORDS: Aneurysms, interventional

Paper 144 Starting at 10:53 AM, Ending at 11:01 AM
A Prospective Trial of 3 T and 1.5 T Time-of-Flight and Contrast-Enhanced MR Angiography in the Follow Up of Coiled Intracranial Aneurysms

Kaufmann, T. J. · Huston, J. · Cloft, H. · Mandrekar, J. · Bernstein, M. · Kallmes, D.

Mayo Clinic Rochester, MN

PURPOSE

Imaging follow up is necessary after endovascular coil of intracranial aneurysms because aneurysms may recur. Catheter cerebral angiography is used frequently and is the reference standard, but it is invasive and carries risk of serious complications. MR angiography (MRA) has shown promise in detecting aneurysm remnants or recurrences after endovascular coil. However, MRA techniques are varied, and their accuracy relative to catheter angiography and to each other has not been well established. We present results of a prospective clinical trial comparing four different MRA techniques (TOF and CE at both 1.5T and 3T) to catheter angiography in follow up of coiled intracranial aneurysms.

MATERIALS & METHODS

Sixty-three previously coil embolized intracranial aneurysms in 58 patients, ages 38-76 years, were evaluated in follow up with diagnostic cerebral angiography at 155-2529 days (median 369 days) after coiling. Four MRA techniques also were performed on each patient within 1 week of this follow-up angiography: TOF and CE MRA at both 1.5T and 3T. Catheter angiograms were evaluated for aneurysm remnants by two interventional neuroradiologists, who were blinded to MRA results, and discrepancies in their interpretations were adjudicated with each other. MR angiography exams were similarly evaluated by two diagnostic neuroradiologists, who were blinded to concomitant angiography results, and discrepancies in their interpretations were adjudicated with each other. Two ordinal outcome variables were described for each coiled aneurysm: class of aneurysm remnant (1-4, using Raymond scale) and change since comparison or postcoiling catheter angiography (better, same, worse). Results of each MRA technique were compared to results for catheter angiography by calculating percent accuracy. By creating binary outcome variables from ordinal outcome variables, also sensitivity and specificity for each MRA technique was calculated.

RESULTS

Accuracies in assessing exact aneurysm remnant class (1-4) were 46%, 52%, 46%, and 48% for 1.5T TOF, 1.5T CE, 3T TOF, and 3T CE MRA techniques, respectively. Accuracies in assessing change since previous angiography were 58%, 64%, 62%, and 70% for these techniques, respectively. Their sensitivities were 92%, 86%, 89%, and 89%, respectively, for the detection of any aneurysm remnant (classes 2-4). Their sensitivities were 52%, 70%, 52%, and 70%, respectively, for detection of a class 3 or 4 aneurysm remnant. Their sensitivities were 31%, 31%, 38%, and 44%, respectively, for detection of aneurysm remnant growth since comparison angiography. None of the sensitivity differences between MRA techniques was statistically significant at the level of p=.05.

CONCLUSION

The four techniques of TOF and CE MRA at 1.5T and 3T were similarly sensitive for the detection of any aneurysm remnant after endovascular coil embolization. These techniques had good sensitivity for detecting the presence of an aneurysm remnant, but sometimes had difficulty in differentiating among the different classes or types of aneurysm remnants. The sensitivity of CE MRA at both field strengths exceeded that of TOF MRA for the detection of larger (class 3 and 4) remnants, although this observation did not reach statistical significance. These four MRA techniques had relatively poor sensitivity in the assessment of aneurysm remnant worsening since comparison angiography.

KEY WORDS: Aneurysm, magnetic resonance angiography

Paper 145 Starting at 11:01 AM, Ending at 11:09 AM

Very Long-Term Follow Up of Coiled Intracranial Aneurysms Using MR Angiography at 3.0 T

Majoie, C. B. L. · Sprengers, M. E. · Rinkel, G. J. · Sluzewski, M. · van Rijn, J. C. · Velthuis, B. K. · de Kort, G. · Schaafsma, J. · van Rooij, W. J.

1Academic Medical Center, Amsterdam, THE NETHERLANDS, 2University Medical Center, Utrecht, THE NETHERLANDS, 3Elisabeth Hospital, Tilburg, THE NETHERLANDS

PURPOSE

Long-term angiographic results of coiled intracranial aneurysms are not established yet. We used MRA to assess the incidence of reopening of aneurysms with a complete or near complete occlusion at 6-month follow-up angiography, 5 to 12 years after coiling. Moreover, we assessed incidence of growth of untreated additional aneurysms and the development of new aneurysms.
Magnetic resonance angiography (MRA) at 3.0 T was performed 5-12 years after coiling in 113 coiled intracranial aneurysms of which 111 aneurysms were included that showed (near) complete occlusion at 6-months follow-up angiography. Patients were selected from data bases from three participating hospitals. MR angiography was compared with initial and follow-up angiographic images for recurrence of the coiled aneurysm, growth of additional untreated aneurysms and new aneurysm formation.

**RESULTS**

Cumulative incidence of reopening of the coiled aneurysm after 5-12 years (mean 6 years) was 3.6 % (4 in 111). Of four recurrences, one was major and three were minor. One aneurysm was additionally coiled (0.9%). Annual incidence of new aneurysm formation was 0.46% (3 de novo aneurysms in 646 follow-up years). All three new aneurysms were small (2-3 mm). Of 18 untreated additional aneurysms one showed minimal growth.

**CONCLUSION**

Incidence of reopening after 5-12 years (mean 6 years) of a coiled aneurysm with (near) complete occlusion at 6 months was 3.6% and need for retreatment was 0.9 %. Incidence of growth of untreated additional aneurysms and development of new aneurysms was low and had no consequences in terms of treatment.

**KEY WORDS:** Aneurysms, treatment, follow up

**MATERIALS & METHODS**

A total of 114 embolized cerebral aneurysms were imaged with the same dedicated high-resolution 3D time-of-flight (TOF) MRA sequence (03x0.4x0.5 voxel size, TR 25 msec, TE 6.9 msec, FA 20) acquired both before and following intravenous contrast agent (01 mmol/kg) on 1.5 T scanners. The two sets of images were analyzed simultaneously by the two observers. Aneurysms were classified according to the location (anterior or posterior circulation) and size: 5 mm or less (size 1), 6-10 mm (size 2) and greater than 10 mm (size 3). For each aneurysm it was determined whether the contrast-enhanced images showed additional aneurysm filling and/or increased confidence in detection of the residual filling (contrast help) as well as whether they decreased diagnostic confidence due to venous contamination (venous confusion). Our institutional review board approved this investigation.

**RESULTS**

Six studies were excluded secondary to suboptimal technique or motion artifact. A total of 108 aneurysms were included in the study. There were 86 (79.6%) anterior and 22 (20.4%) posterior circulation aneurysms. For the anterior circulation aneurysms, contrast helped evaluation in only six cases (6.9%) and lead to venous confusion in 18 (20.9%). For the posterior circulation aneurysms, contrast helped in 0 cases and caused venous confusion in one case (4.5%). There were no significant differences between anterior and posterior circulation in terms of contrast help (p = 0.2017) or venous confusion (p = 0.0719). For the 32 aneurysms in size 1 (< 5 mm) group, contrast aided one case and degraded one case secondary to venous confusion. Of the aneurysms in size 2 (6-10 mm) group, contrast helped in five cases and degraded evaluation in eight cases. With the aneurysms greater than 10 mm (size 3), contrast benefited 0 studies and impaired evaluation in one study. Finally, there were no significant differences in contrast help (p = 0.2528) and venous confusion (p = 0.2685) among the three aneurysm sizes. Contrast help observed in six aneurysms was minimal and did not affect patient management in any of the cases.

**CONCLUSION**

Gadolinium contrast administration for MRA of embolized cerebral aneurysms does not improve diagnostic accuracy and may lead to false positive findings.

**KEY WORDS:** MRA, embolized cerebral aneurysms, gadolinium contrast

**PAPER 147 STARTING AT 11:17 PM, ENDING AT 11:25 AM
Withdrawn**

**PAPER 148 STARTING AT 11:25 AM, ENDING AT 11:33 AM
Preliminary Clinical Results of Clarity Study**

Cognard, C. · Pierot, L. · Clarity Study Group

1 CHU de Toulouse, Toulouse, FRANCE, 2CHU de Reims, Reims, FRANCE

**PURPOSE**

The goal of Clarity study is to evaluate: 1. The role of embolization of intracranial ruptured aneurysms compared to surgery and abstaining; and 2. The morbi-mortality of embolization when performed consecutively in first intention with results controlled by an independent clinical monitoring lab.

**MATERIALS & METHODS**

Twenty-one French centers have participated to this study (37 investigators). Inclusion criteria were: every patient from 18 to 80 years old presenting an aneurysm of less than 15...
mm ruptured in the last 7 days. Exclusion criteria: Dissection
or fusiform aneurysms; aneurysms associated to AVM;
aneurysms already treated by clip or coils; and patients
already treated from another aneurysm. All the patients
were treated with GDC coils with or without coil-assisting
devices. Clinical evaluation (GOS, mRs) was performed
before and immediately after embolization then at hospital
discharge. They will be followed 3 to 6 and 12 to 18 months.
Rate Normal Life Index: Scale of quality of life will be
answered by the patient.

RESULTS
Four hundred eight patients were treated by embolization:
43.6% of female (mean age: 51 years old), 27.7% presenting
arterial hypertension; 46.8% smokers. The aneurysm
was located at the anterior circulation in 90.9% and posterior
circulation in 9.1% of the cases. There were multiple
aneurysms in 17.9% of the cases. Embolization procedure
was successful in 97.5% of the cases. It was performed with
coils alone in 79%, with balloon remodeling technique in
20.4% and with stent in 0.5% of the cases. Neurologic status
was improved in 38%, unchanged in 42.3%, worsened
13.6% of the patients died. Thrombo-embolic complications occurred in
6.1%, worsened in 8.6% of the cases. 13.6% of the
patients died. At hospital discharge, neurologic
status was improved in 38%, unchanged in 42.3%, worsened
in 6.1%, worsened in 8.6% of the cases. Neurologic status
died. Thrombo-embolic complications occurred in
50 cases leading to a permanent deficit in 12 patients.
Aneurysm rupture occurred in 12 cases leading to a perma-
nent deficit in one case but no death.

CONCLUSION
Clarity study is the first multicenter, prospective, consecu-
tive and controlled study of the embolization considered as
the first intention treatment of ruptured aneurysms.
Preliminary clinical results show that despite consecutive
enrollment the morbi-mortality and technical related compli-
cations are consistent with those from ISAT.

KEY WORDS: Embolization, morbi-mortality, consecutive
study

Paper 149 Starting at 11:33 AM, Ending at 11:41 AM
Potential Value of Blood Flow Simulations in Cerebral
Aneurysms before Endovascular Treatment: Feasibility
Study
Karmonik, C. 1,2 · Yen, C. 1 · Klucznik, R. 1 · Grossman, R. 1 ·
Benndorf, G. 1
1 The Methodist Hospital Research Institute, Houston, TX,
2 Weill Medical College of Cornell University, New York,
NY, 1 The Methodist Hospital, Houston, TX

PURPOSE
To evaluate hemodynamic patterns calculated with computa-
tional fluid dynamics (CFD) in cerebral aneurysms before
and after endovascular treatment (EVT) based on 3D digital
subtraction angiographic (DSA) images. Calculation of wall
shear stress (WSS) and dynamic pressure may predict risk of
aneurysm rupture prior to and after EVT of ruptured and
unruptured aneurysms.

MATERIALS & METHODS
Four cerebral aneurysms were studied: one aneurysm of the
anterior communicating artery (1, ruptured), two internal
carotid artery aneurysms in the same artery segment (2 and
3, unruptured) and one basilar tip aneurysm (4, ruptured).
Three-dimensional computational meshes were created from
3D DSA images (Siemens Medical Solutions) acquired
before and immediately after EVT. The Navier-Stokes equa-
tions were solved for unsteady flow conditions (Fluent,
ANSYS Inc.). Quality of 3D DSA images was evaluated and
convergence of CFD simulations was assessed for different
mesh size and time steps. Pathlines, dynamic pressures and
WSS were calculated for aneurysmal wall before and for the
coil-artery interface after treatment (Fluent, ANSYS Inc. and
Ensight, Inc.).

RESULTS
Mesh independent solutions were obtained with mesh sizes of
82,000-165,000 elements and a time step of 5 ms. Residual
necks were identified in post 3D DSA images for aneurysms 1, 2 and 3. Wall shear stress was lower at the walls
of residual necks than at the arterial wall in the immediate vicinity of the aneurysm. Average WSS values at the coil-
artery interface were calculated as 2.2 Pascal (Pa) (1), 7.5 Pa
(2), 1.5 Pa (3) and 33 Pa (4). These values were higher than
average WSS on the aneurysmal wall before treatment: 1.3
Pa (1), 6.8 Pa (2), 3.1 Pa (3) and 11.9 Pa (4). Spatial correlations
between inflow zones of the aneurysms identified in the
CFD simulations before treatment and areas of high WSS and
high dynamic pressure after treatment were identified (Figure 1).

CONCLUSION
Three-dimensional DSA image data acquired after EVT are
suitable for use in CFD simulations. Average WSS at inter-
face between parent artery and treated aneurysm was higher
than in ostium area and at aneurysmal wall before treatment.
Wall shear stress at the wall of residual necks was low. Inflow
regions identified in the CFD simulations with image
data acquired before treatment correlated spatially with areas
of high WSS and dynamic pressures in CFD simulations
using 3D DSA image data after treatment. Computational
fluid dynamics simulations prior to endovascular treatment
may have potential value for assessing hemodynamic param-
eters after treatment and consequently for treatment out-
come.

KEY WORDS: Intracranial aneurysm, endovascular treat-
ment, hemodynamics simulation
Paper 150 Starting at 11:41 AM, Ending at 11:49 AM
Dynamic CT Angiography, Fluoroscopy, and High-Resolution Tomography Using a Flat-Panel Volume CT: Feasibility of Omni Scanning for Neurointerventional Applications

Cheung, A. C.; Aronson, J. P.; Mitha, A. P.; Leidecker, C.; Sarwar, A.; Ogilvy, C. S.; Brady, T.; Gupta, R.

1Massachusetts General Hospital, Boston, MA, 2Siemens Medical Solutions USA, Malvern, PA

Purpose
Currently, three modalities play a key role in x-ray imaging: radiography and fluoroscopy, angiography, and computed tomography. Despite using x-ray as a common source, these modalities remain distinct, with each requiring different mechanical gantries, room setups and detector designs. The recently introduced prototype flat-panel volume CT (fp VCT) integrates these three capabilities and enables multi-scanning functions into one scanner. Due to its unique digital flat-panel design, the fp VCT can render high-resolution scanning functions into one scanner. Due to its unique digital flat-panel design, the fp VCT can render high-resolution (150 microns) CT scans, visualize temporally evolving processes, and can be used for fluoroscopically guided procedures. We sought to demonstrate the feasibility of utilizing the multifunctionalities of this scanner with a carotid aneurysm model in rabbits.

Materials & Methods
From June 2006 to December 2007, the flat-panel VCT was used to image 16 rabbits that underwent right common carotid cutdowns in the neck as a model for intracranial aneurysms. Imaging was conducted at various time-points postaneurysm-creation procedure. The aneurysms were imaged either before or after endovascular treatment with a fibrin gel matrix. Conventional angiography, computed tomography and dynamic imaging were conducted in all 16 rabbits. Projection datasets were acquired using different modes, including high-resolution volumetric computed tomography and dynamic imaging techniques. Geometric indices, surface features and dynamic pulsatility of aneurysms were evaluated. Additionally, conventional angiography and fluoroscopy were performed. The accuracy, precision and ease of use of fluoroscopy in performing image-guided biopsies, catheter angiographies and aneurysm treatment were assessed.

Results
There were no deaths or major complications arising from the performance of these scans. Radiographic assessment of the aneurysms demonstrated an assortment of aneurysm sizes with irregular surface contours and geometry. A small degree of pulsatility is observed also in these aneurysms from dynamic imaging analysis. Furthermore, angiographies were performed without any limitations. The acquired data sets were similar to those from standard C-arms, with good visualization of the arterial, capillary and venous phases during bolus-transit from any chosen angle. The gantry-orientation shift from anteroposterior (AP) to lateral (LAT) projection was also quicker than that of the C-arm. For fluoroscopy, the fast transition from fluoroscopic to tomographic mode enabled accurate localization of the catheter’s position. While the road-mapping or the digital subtraction angiography (DSA) features have not been implemented for the current prototype, its capability for biopsies or aneurysm treatment was functional and unrestrictive.

Conclusion
We have validated the feasibility of performing conventional angiography, volumetric CT, fluoroscopy and dynamic imaging in the prototype flat-panel VCT scanner. The quick transition from fluoroscopy to tomography is a unique capability of the scanner, and implementing additional features (i.e., DSA) will further bolster its fluoroscopic function. While the prototype fp VCT is a powerful tool suited for animal imaging, the omniscanning flat-panel technology offers distinct advantages for clinical purposes. Specifically, its flexibility and multifunctionality would serve valuable functions for neurointerventional applications.

Key Words: Flat-panel volume CT, aneurysm model, dynamic CT angiography

Paper 151 Starting at 11:49 AM, Ending at 11:57 AM
Dynamic Subtracted Angiography with 320 Multislice CT

San Millan Ruiz, D.; Gailloud, P.; Wyse, G.; Murphy, K.
The Johns Hopkins Hospital
Baltimore, MD

Purpose
The purpose of work is to report on the initial experience with 320 multislice 4D subtracted dynamic CT angiography (4D SCTA) in the evaluation of patients with various neurovascular disorders.

The z-axis coverage using a 320 multislice CT is 16 cm, which is sufficient to provide whole-brain coverage and perform dynamic CT angiography as well as whole brain perfusion.

Materials & Methods
Eleven patients with various cerebrovascular disorders (Table 1) were investigated with 4D CTA. In nine patients 4D SCTA was correlated with catheter angiography (DSA). All patients underwent a standard unenhanced CT and a low dose 4D SCTA (80 kVs and 100 mAs). The temporal sampling intervals during dynamic scanning were tailored to each pathology. For instance when studying DA VF, whole-brain data-volumes were acquired at rotation gantry speeds of 0.36-0.5 seconds on cine-mode, as opposed to gantry speed of one rotation/second every other second in the evaluation of vertebral artery dissection or aneurysm follow up. All source 4D CTA images underwent subtraction.

<table>
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<tr>
<th>Table 1. Patient population</th>
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RESULTS
In the cases of DAVF, subtracted 4D SCTA demonstrated all the arterial feeders and venous outflow patterns shown on DSA, and allowed for an excellent morphologic and hemodynamic appreciation of the lesion. In one of the aneurysm studies, subtracted 4D SCTA managed to completely remove the stent and coil-pack allowing for excellent appreciation of the parent artery/aneurysm neck interface, perfectly correlating with DSA findings. In the two remaining aneurysm follow-up studies (1 patient with 1 coiled aneurysm, 1 patient with 3 clipped aneurysms), complete subtraction of the metal implants could not be obtained due to patient motion artifacts, and 4D SCTA was inferior to DSA in these cases. In the case of spinal DAVF, 4D SCTA disclosed an abnormal arterialized vein flowing caudo-cranially at the level of the conus medullaris and exiting the spinal canal through T10 neural foramen, which was confirmed by surgery. In the case with a complex venous malformation, 4D SCTA demonstrated the absence of an arteriovenous shunt and allowed for precise dynamic and morphological appreciation of the lesion comparable to DSA. In the patient with an orbital vascular malformation, 4D SCTA showed slow filling of the malformation. In the case of deep venous thrombosis involving the internal cerebral veins and basal veins, 4D CT A allowed for a formal diagnosis that had eluded the MRI study.

CONCLUSION
320 multislice CT has a high temporal resolution and a 16 cm z-axis coverage which allows whole-brain dynamic 4D SCTA, and proves to be an invaluable diagnostic tool for neurovascular disease rivaling DSA.

Key Words: Dynamic subtraction CT angiography, 320 multislice CT, neurovascular disease

Paper 152 Starting at 11:57 AM, Ending at 12:05 PM
Combined Neuroform Stenting and Coil Embolization of Acutely Ruptured Aneurysms: Report of 41 Consecutive Cases
Horowitz, M. B.
University of Pittsburgh Pittsburgh, PA

PURPOSE
The Neuroform Stent System (Boston Scientific Neurovascular, Fremont, CA), a microcatheter delivered nitinol stent has been used in the United States since November 2002, to assist with the endovascular coiling of unruptured intracranial aneurysms. There has been very little information available in the literature on its use in ruptured aneurysms.

MATERIALS & METHODS
We undertook a retrospective study of all patients with ruptured aneurysms treated with a Neuroform stent between March 2004 and February 2007 via chart review. Data were gathered regarding clinical presentation, angiographic presentation and results, use of antplatelet and anticoagulant medications, hemorrhagic complications related to ventriculostomy placement, noncerebral hemorrhagic complications, aneurysm bleeding and posttreatment aneurysm rebleeding.

RESULTS
Between March 2004 and February 2007, 24 women and 16 men ranging in ages from 37-81 years (mean 66) harboring 41 aneurysms were studied. Almost all patients received some form of anticoagulation and/or antplatelet therapy during and/or after the embolization procedure. Complications attributable to anticoagulation and antiplatelet administration were not elevated in this patient population. Aneurysm obliteration results were excellent with 93% of lesions completely treated.

CONCLUSION
The use of Neuroform stents in conjunction with coil embolization of acutely ruptured intracranial aneurysms appears to have an acceptable risk: benefit ratio.

KEY WORDS: Aneurysm, ruptured, stent

Paper 153 Starting at 12:05 PM, Ending at 12:13 PM
Use of Neuroform® Stent for the Treatment of Unruptured Intracranial Aneurysms: Acute and Intermediate Posttreatment Results from a Monocentric Registry
Vendrell, J. · Riquelme, C. · Bourbotte, G. · Moynier, M. · Seris, C. · Brunel, H. · Bonafe, A.
CHU Montpellier Hospital Montpellier, FRANCE

PURPOSE
Neuroform® is a self-expending nitinol stent, specifically designed for treating challenging aneurysms. We intend to report the safety and efficacy of the use of Neuroform® stent when facing wide neck aneurysms previously treated or not.

MATERIALS & METHODS
From June 2003 to December 2006, 56 patients (38 women and 18 men; mean age: 52.4 ± 14.8 years) having a total of 62 wide neck unruptured aneurysms were treated using Neuroform® stents (Boston Scientific, Neurovascular, Fremont, CA). Forty aneurysms were treated in one session (65%) and 22 previously treated aneurysms were retreated after partial recanalization (35%). The aneurysms were located mainly in the anterior circulation (n = 55): carotidophthalmic artery (n = 18), middle cerebral artery (n = 14), intracranial bifurcation of internal carotid artery (n = 7). Subarachnoid aneurysms (n = 55) outnumbered subdural aneurysms (n = 7). Different types of coils were used: bioactive coated coils (55% Matrix® coils, 5% Nexus® coils), 29% hydrocoils or bare platinum coils (11%). Technical and clinical complications were recorded systematically and the occlusion rate determined by angiographic analysis.

RESULTS
Out of the 64 Neuroform® stents placed, 22 were for treating partially recanalized aneurysms in 21 patients, one patient being treated twice for bilateral carotido-ophthalmic aneurysms. No significative differences in terms of procedure-related complications were observed between the two groups. Overall, technical complications due to stenting or coiling were encountered in eight of 64 procedures (14%). One coil extrusion was treated by stent rescue (1.6 %) and no neurologic complications were observed. A stent-induced arterial wall perforation was noted in one case (1.6%) with
worsening of the neurologic preexisting deficit. Thromboembolic complications due to the stent were recorded in six procedures (9.4%) and were treated with IV Reopro. No mortality related to the treatment was recorded and the acute permanent morbidity was 2/56 patients (3.6%). Complete occlusion was achieved in 36% aneurysms, neck remnant in 27% and aneurysm remnant in 37% aneurysms. A mid term follow up (15.3 ± 12.1 months) was performed in 47 patients (52 aneurysms). Two cases of in-stent stenosis clinically silent were observed 6 and 15 months after embolization, respectively. In one case, the stent impeded the retreatment of the aneurysm. Complete occlusion was observed in 66% aneurysms, neck remnant in 16%, and aneurysm remnant in 18% aneurysms. Five cases (10%) required retreatment. Compared to the acute angiographic results, mid-term evaluation showed stable occlusion for 18% of aneurysms, improved outcome for 44% and worsening for 28% of aneurysms.

CONCLUSION
Safety of intracranial stenting for aneurysms has been demonstrated as untoward complications were not different from coiling with other adjunctive techniques. Due to the wide variety of selected aneurysm cases, improvement of aneurysm occlusion has not been demonstrated and durability of the treatment will need to be investigated.

KEY WORDS: Aneurysm treatment, Neuroform stent

Paper 154 Starting at 12:13 PM, Ending at 12:21 PM
3D Rotational Angiography: The New Gold Standard in Detection of Additional Intracranial Aneurysms

Peluso, J. P. P. · van Rooij, W. · Sluzewski, M.
St Elisabeth Ziekenhuis
Tilburg, THE NETHERLANDS

PURPOSE
The purpose of this study is to compare 3D rotational angiography (3D RA) and digital subtraction angiography in the detection of small additional intracranial aneurysms.

MATERIALS & METHODS
Three hundred fifty 3D datasets of one vascular tree of 350 patients with at least one intracranial aneurysm on the 3D dataset were reevaluated for the presence of additional aneurysms by two observers in consensus. Two other observers, blinded to 3D images, reevaluated DSA images of the same 350 vascular trees for these additional aneurysms. Results were compared.

RESULTS
In 350 3D datasets, 350 target aneurysms and 94 additional aneurysms were detected. Mean size of 94 additional aneurysms was 3.54 mm (median 3, range 0.5-17 mm). Proportion of aneurysms ≤ 3 mm was significantly higher in additional aneurysms (61 of 94, 65%) than in target aneurysms (61 of 350, 17%) (Chi Square, P < 0.0001). Of 94 additional aneurysms, 27 (29%) were missed on DSA by both observers. Mean size of the missed aneurysm was 1.94 mm (median 2, range 0.5-4 mm). Proportion of aneurysms ≤ 3 mm in missed additional aneurysms (26 of 27, 96%) was significantly higher than in all additional aneurysms (61 of 94, 65%) (Chi Square, P = 0.0035). Location of missed additional aneurysms was not different from location of all additional aneurysms.

CONCLUSION
Three-dimensional RA depicts considerably more small (≤ 3 mm) additional aneurysms than DSA. In selected patients, accurate detection of these aneurysms may have consequences for choice of treatment modality and for frequency and duration of imaging follow up.

KEY WORDS: Aneurysms, 3D angiography, detection rate

Paper 155 Starting at 12:21 PM, Ending at 12:29 PM
New Challenge to Estimate the Rupture Process of ICA Aneurysm

Fukui, K. · Qian, Y. · Umezua, M. · Takao, H. · Ishibashi, T. · Murayama, Y.
1Waseda University, Okubo, Shinjuku-ku, Tokyo, JAPAN, 2The Jikei University School of Medicine, Shinbashii Minato-ku, Tokyo, JAPAN

PURPOSE
The most serious consequence of cerebral aneurysms is their rupture causing intracranial bleeding into subarachnoid space and a high mortality rate. Although the natural rupturing reasons of cerebral aneurysms are not well understood, hemodynamic performances are being discovered to be important factors in the rupture of cerebral aneurysms. In this research, we proposed a new numerical method to estimate the aneurysm rupturing process.

MATERIALS & METHODS
The validated and calibrated computational fluid dynamics (CFD) technique, basing on a commercial software CFX-ver.10 (ANSYS), was introduced in this research. The simulations were performed under pulsatile flow conditions which measured at internal carotid artery. The geometries of aneurysm and its parent vessels were taken by using three-dimensional digital subtraction angiography (3D DSA) which was a raw clinical data from The Jikei University School of Medicine (JUSM). To confirm the accuracy of results, the calculation and data transfer systems were validated using in vitro and in vivo methods in our laboratories. The validations showed good agreements between calculation and measurement. Continuing to our research of aneurysm risk analysis, we have introduced a four-dimensional method to approach the pulsatile hemodynamic process. The pressure loss (PL) and wall shear stress (WSS) were not only compared at instantaneous conditions, but also the results were analyzed under time-dependent pulsatile conditions.

RESULTS
Two small size (5 mm) and similar aneurysms (ICA) were selected in this research. One is rupture-aneurysm (the aneurysm ruptured in 6 months), and another aneurysm is unruptured which is continuously observed at JUSM. The blood flows in a rupture-aneurysm were much more complex to compare the flow inside of unruptured aneurysm. In the rupturing aneurysm, there was a strong swirl flow in the center of aneurysm and a strong flow crash into aneurysm surface. The systolic velocities at the tops of aneurysms were 35
cm/s and 5cm/s in the rupture case and unruptured case, respectively. These results indicated that blood circulation through the rupture-aneurysm was more likely to be activated. Blood passed through rupture-aneurysms was calculated to lose about 30 times more energy than unruptured aneurysm. Furthermore, the PL and WSS on the aneurysm surfaces were observed pulsatile condition. By comparison with the results of dPL/dt from systolic to diastolic, we found that the dPL/dt was 20 Pa/s m$^{-3}$ in the rupture-aneurysm. Although, the WSS was instantaneously observed at low level both ruptured and unruptured aneurysms, our four-dimensional analysis positively demonstrated a higher gradient distribution at the top of rupture-aneurysm surface.

CONCLUSION
A complex flow pattern inside of the rupture-aneurysm has been observed by visualizing our pulastile flow simulation. A four-dimensional and time-dependent analysis method have been introduced to estimate the risk analysis of aneurysm rupture. The results clearly indicated that the PL and WSS led us to better understand the mechanism of cerebral aneurysm rupture. To validate the new proposal, a series of new clinical cases, which include rupture, unrupture, and rupture-aneurysms, have been simulated at our laboratory.

KEY WORDS: Aneurysm, rupture, CFD

Tuesday Morning
10:45 AM – 12:30 PM
Room 206/207

(20b) ADULT BRAIN: Trauma, Inflammation & Ischemic Disease/Excerpta
(Scientific Papers 156 – 169)

See also Parallel Sessions
(20a) INTERVENTIONAL: Aneurysms I
(20c) ADULT BRAIN: Functional II
(20d) PEDIATRIC: Functional Imaging

Moderators: TBD
Paper 157 Starting at 10:53 AM, Ending at 11:01 AM
Computer Assessment of Head CT in Suspected Traumatic Brain Injury
Yuh, E. L. · Gean, A. D. · Manley, G. T. · Wintermark, M.
University of California San Francisco
San Francisco, CA

PURPOSE
To determine the accuracy of computer software developed for evaluation of noncontrast CT studies of the brain in patients with suspected traumatic brain injury, employing a board-certified neuroradiologist with more than 20 years of experience in imaging of head trauma as the gold standard.

MATERIALS & METHODS
We designed computer software that performs 1) fully automated detection and volumetric analysis of acute intracranial hemorrhage, 2) fully automated detection and volumetric analysis of basal cisterns, 3) fully automated quantitative analysis of shift of the lateral ventricles relative to the midline falx cerebri, and 4) fully automated assessments of the Marshall and Rotterdam scores. The software's graphical user interface (Figure) displays key pathological and anatomical features as color overlays on the original noncontrast head CT data. Next, noncontrast head CT studies performed in 250 patients evaluated at San Francisco General Hospital in 2006 for suspicion of acute traumatic brain injury were identified retrospectively and independently reviewed by a board-certified neuroradiologist and by the computer algorithm for presence of: 1) subarachnoid hemorrhage or parenchymal contusion, 2) subdural or epidural hematoma, 3) clinically significant midline shift (> 5 mm), and 4) normal, partly effaced, or completely effaced basal cisterns. Using the neuroradiologist interpretation as the gold standard, sensitivity and specificity of the computer algorithm for these features were calculated.

RESULTS
Sensitivities and specificities of the computer algorithm were as follows: 1) sensitivity 98% and specificity 59.5% for acute intracranial hemorrhage, 2) sensitivity 88% and specificity 94% for clinically significant midline shift (> 5 mm), 3) sensitivity 75% and specificity 94% for partial or complete effacement of basal cisterns. Overall sensitivity and specificity for any acute intracranial abnormality were 98% and 57% respectively.

CONCLUSION
Computer-aided assessment of noncontrast head CT can achieve high sensitivities for acute intracranial abnormalities, particularly acute intracranial hemorrhage, in the setting of suspected traumatic brain injury (TBI). Applications include improvement of workflow in emergency neuroradiologic evaluation of patients with suspected TBI, as well as the development of more objective, standardized metrics for the purposes of improved outcomes prediction, triage to appropriate early treatment, and stratification of research subjects in clinical trials of experimental interventions according to severity of injury.

KEY WORDS: Trauma, CT, CAD

Paper 158 Starting at 11:01 AM, Ending at 11:09 AM
Cranial CT Venography in Evaluation of Dural Sinus Injuries Associated with Skull Base Fracture
Wolansky, L. J. · Jedynak, A. R. · Punia, V. · Merkulov, A.
New Jersey Medical School/University of Medicine & Dentistry of New Jersey
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PURPOSE
The head and C-spine CT has become an indispensable tool in clearing the cervical spine and head in trauma patients. Our purpose is to report on the value of cranial CT venography in the detection of clinically unsuspected dural sinus injuries and associated epidural hematomas in the setting of skull base fractures.

MATERIALS & METHODS
Thirteen trauma cases were examined in which CT imaging of the head and C-spine demonstrated a skull base fracture. CT venography (CTV) was carried out to rule out possible dural sinus injury. CT venography was performed on a multidetector row CT using a power intravenous contrast injection of 5 cc/second.
RESULTS
Twelve of 13 cases of skull base fracture demonstrated the presence of dural sinus abnormalities. Dural sinus stenosis, near-occlusion, occlusion, and displacement were encountered. In one instance, there was complete torcular detachment from the inner table associated with a large epidural hematoma and sinus occlusion. In another case, the transverse/sigmoid junction was detached completely from the inner table but remained normal in caliber. In all cases with dural sinus injury, probable venous or arterial epidural hematomas were associated. In one instance multiple sites of contrast extravasation, the presumptive source of the epidural hematoma was identified.

CONCLUSION
Cerebral CT venography is an effective, and possibly under-utilized, method for evaluation of dural sinus injury in the setting of skull base fractures.

KEY WORDS: Epidural, sinus, injury

Paper 159 Starting at 11:09 AM, Ending at 11:17 AM
Temporal Window of Metabolic Brain Vulnerability to Concussion: A Pilot 1H-MRS Study in Concussed Athletes

Ludovici, A. · Marziali, S. · Floris, R. · Vagnozzi, R. · Signoretti, S. · Garaci, F. · Gaudiello, F. · Melis, M. · Meschini, A. · Simonetti, G.
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Rome, ITALY

PURPOSE
In the present study, the occurrence of the temporal window of brain vulnerability was evaluated in postconcussed athletes by measuring N-acetylaspartate (NAA) using proton MR spectroscopy (1H-MRS).

MATERIALS & METHODS
Thirteen nonprofessional athletes who suffered from a sport-related concusive head injury were examined for NAA determination by means of 1H-MRS at 3, 15 and 30 days postinjury. All athletes but three suspended their physical activity. Those who continued their training suffered from a second concusive event and underwent a further examination at 45 days from the initial injury. The single case of one professional boxer who was studied before the match and 4, 7, 15 and 30 day following a knock out is presented also. Before each MR examination, patients were asked for symptoms of mTBI, including physical, cognitive, emotional and sleep disturbances. Data of 1H-MRS recorded in five normal, age-matched, control volunteers, previously screened to exclude prior head injuries, were used for comparison. Semi-quantitative measurement of NAA relative to creatine (Cr) and choline (Cho) containing compounds was performed from proton spectra obtained with a 3 T MR system.

RESULTS
With respect to the values of the NAA/Cr (2.21 ± 0.11) ratio recorded in controls, singly concussed athletes, at 3 days after the concussion, showed a decrease of 18.5% (1.80 ± 0.04; p < 0.001). Only a modest 3% recovery was observed at 15 days (1.88 ± 0.1; p < 0.001) and, at 30 days postinjury, NAA/Cr equaled 2.15 ± 0.1, revealing full metabolic recov-

CONCLUSION
Results of this pilot study carried out in a cohort of singly and doubly concussed athletes, examined by 1H-MRS for their NAA cerebral content at different time point after concussive events, demonstrates that, also in human beings, concussion opens a temporal window of brain metabolic imbalance, the closure of which does not coincide with resolution of clinical symptoms. The recovery of brain metabolism is not related linearly with time. A second concusive event prolonged by 15 days the time of NAA normalization. Although needing the confirmation in a larger group of subjects, these results showed that NAA measurement by 1H-MR spectroscopy is a valid tool in assessing the full cerebral metabolic recovery after concussion, thereby suggesting to add its routine use in establishing when to return mTBI-affected athletes to play.

KEY WORDS: 1H-MRS, concussion, brain vulnerability

Paper 160 Starting at 11:17 AM, Ending at 11:25 AM
Traumatic Brain Injury: Diffusion Tensor MR Imaging in Monitoring Therapeutic Effects in a Swine Model

Schwartz, E. D. · Zhang, J. · Krejza, J. · Gor, D. · Rotoli, J. · Smith, D. H.
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'University of Pennsylvania School of Medicine, Philadelphia, PA, 'Medical University of Gdansk, Poland, Gdansk, POLAND

PURPOSE
To determine whether diffusion tensor MRI (DTI) can detect diffuse axonal injury (DAI) in regions of white matter that appear normal on conventional MRI, using an animal model with traumatic brain injury (TBI).

MATERIALS & METHODS
A double injury model of DAI via head rotational acceleration and left parietal contusion brain injury was created in 10 pigs. Preinjury MRI/DTI of the brain was performed in four animals (normal controls), whereas MR studies in all pigs were obtained within 2 hours (day 1) and 72 hours (day 3) following injury. Five of the injured pigs were treated with procoagulation recombinant factor VIIa (rFVIIa) and five received placebo. Diffusion tensor imaging analysis involved regions of interest in the noncontused right frontal lobe white matter as well as right descending white matter. Analysis on the contused side involved the left descending white matter. Histopathology included quantitative analysis of swollen axonal profiles.
RESULTS
Conventional MR sequences demonstrated no signal abnormality in the noncontused, right hemisphere, either in those animals treated with rtVIIa or placebo. In those animals treated with placebo, however, there were decreases in FA and longitudinal diffusion in the same regions shown to have axonal pathology. Notably, animals treated with Novo7 had a reduction of axonal pathology in these regions corresponding with more normal FA and longitudinal diffusion.

CONCLUSION
Conventional MRI techniques demonstrated no abnormalities to suggest DAI in the noncontused hemisphere. Diffusion tensor imaging measurements, however, detected differences between the two animal groups at day 1. These findings suggest that DTI has potential as an outcome measure for treatment of diffuse axonal injury in the acute setting.

KEY WORDS: Diffusion tensor MRI (DTI), traumatic brain injury, swine

Paper 161 Starting at 11:25 AM, Ending at 11:30 AM
Traumatic Clival Subdural Hematoma
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PURPOSE
We present the first case of a clival subdural hematoma described in an adult. Clival hematomas occur with such rarity that they can present the clinician with a challenge in diagnosis and management. This case provides insight into the clinical assessment, diagnostic work up, imaging findings and treatment options in this rare but critically important diagnosis.

CASE REPORT
We present a case of an 18-year-old male who was found collapsed and intoxicated after an alleged assault. On presentation he had a Glasgow Coma Score of 13/15. He had no visible external signs of trauma and his neurologic examination was unremarkable. After a period of close neurologic observation he was discharged home with head injury advice. He re-presented after experiencing visual disturbance, nausea and severe headache for 2 days. Again his neurologic examination was normal. Imaging work up was done and following a stable clinical course the patient was reassured and managed conservatively.

IMAGING FINDINGS
CT demonstrated a hyperdense, retroclival abnormality. MR imaging demonstrated heterogeneous, high signal in the subdural space on T1 and T2 extending from the clivus to the upper border of C6 in keeping with acute hemorrhage. No clival fracture was evident. No other intracranial lesion was identified. A CTA and MRA excluded any vascular malformations. High-resolution CT demonstrated minimal anterior displacement of the odontoid peg and cervical spine MRI demonstrated atlanto-occipital joint high-signal indicative of ligamentous injury. Cervical spine flexion/extension radiographs showed the injury to be stable.

SUMMARY
Retroclival hematomas are a rare entity. They are seen more commonly in the pediatric population with several case reports of extradural and subdural hematomas in this group. They are usually associated with significant trauma and patients frequently have focal neurologic deficits, especially cranial nerve palsies. Our case is unique in the fact that it is the first case of a clival subdural hematoma described in an adult, made more remarkable by the fact that the patient was neurologically intact.

KEY WORDS: Clivus, subdural, hematoma

Paper 162 Starting at 11:30 AM, Ending at 11:38 AM
Use of the Apparent Diffusion Coefficient to Monitor the Effects of Highly Active Antiretroviral Therapy on Progressive Multifocal Leukoencephalopathy: Early Experience
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1University of Chicago Hospitals, Chicago, IL, 2University of North Carolina, Chapel Hill, NC

PURPOSE
Changes in apparent diffusion coefficients (ADC) and diffusion-weighted imaging (DWI) are known to occur with progression of lesions in progressive multifocal leukoencephalopathy (PML), but the effects of treatment on these lesions ADC and their relationship to disease progression is uncertain. Our hypothesis was that ADC/DWI can be used to evaluate the initial effects of highly active antiretroviral therapy (HAART) on PML lesions.

MATERIALS & METHODS
Six patients with AIDS and PML, recently started on HAART were identified retrospectively. One patient with PML and without AIDS was used as a control. Lesions were
classified as slowly or rapidly progressing based on their clinical course and imaging follow up. Images were obtained at pre-HAART (timepoint 1) and post-HAART (timepoint 2). Timepoints (range: 11-90 days) and were spatially normalized to a common reference image. Images then were compared in terms of lesion expansion (changes in total lesion area) and lesion evolution (ADC values within regions of interest placed in the centers and periphery of the lesions normalized against contralateral normal-appearing white matter in the form of an ADC ratio), using a two-sample two-tailed t test.

**RESULTS**

A total of eight lesions (3 rapidly progressing, 5 slowly progressing) were identified in six patients. Compared to the control, slowly progressing lesions had slower growth rates ($p < 0.001$), less growth in peripheral areas of restricted diffusion ($p = 0.03$) and lower average and maximum ADC ratios in the lesion center at both timepoints ($p = 0.001$). Maximum ADC ratios of 2.3 at timepoint 1 and 2.7 at timepoint 2 were seen with rapidly progressing lesions.

**CONCLUSION**

In our small preliminary series, rapidly progressing PML lesions showed higher central ADC values than those showing slow growth during the early period of HAART. Apparent diffusion coefficient may be a surrogate marker and help identify the effects of early therapy on PML lesions.

**KEY WORDS:** Progressive multifocal leukoencephalopathy, diffusion-weighted imaging, HAART

**Paper 163 Starting at 11:38 AM, Ending at 11:46 AM**

**Usefulness of Proton MR Spectroscopic Imaging in the Differentiation of Aerobic Brain Abscesses and Necrotic Glioblastomas Multiforme**

Lai, P. · Chen, J. · Weng, H. · Hsu, S. · Ding, S. · Ko, C. · Fu, J. · Chen, C. 1

1 Veterans General Hospital-Kaohsiung, Kaohsiung, TAIWAN, 2 Chi Mei Hospital, Tainan, TAIWAN, 3 Chang Gung Memorial Hospital, Chaiyi, TAIWAN, 4 National Sun Yat-Sen University, Kaohsiung, TAIWAN.

**PURPOSE**

Abscesses caused by aerobic bacteria (aerobic abscesses) can simulate intracranial glioblastomas multiforme (GBMs) in MRI appearance and single voxel (SV) proton MR spectroscopy. The purpose of our study was to study if MR spectroscopic imaging (SI) can be used to differentiate aerobic abscesses from GBMs.

**MATERIALS & METHODS**

Fifteen patients with aerobic abscesses were studied on a 1.5 T MR scanner using a SV method and a SI method. Proton MR spectra of 15 GBMs with similar conventional MRI appearances were used for comparison. In contrast-enhancing rim of each lesion, peak areas of N-acetylaspartate (NAA), choline (Cho), lipid and lactate (L1), and creatine (Cr) were measured. The peak areas of NAA, Cho, and Cr in the corresponding contralateral normal-appearing white matter or gray matter were measured as NAA-n, Cho-n, and Cr-n in each patient. Thus each patient served as his or her own control. Maximum Cho/Cr, Cho/NAA, LL/Cr-n, Cho/Cho-n, minimum Cr/Cr-n and NAA/NAA-n ratios of corresponding regions in abscesses and GBMs were compared by using the Wilcoxon rank sum test. After receiver operating characteristic curve analysis, diagnostic accuracy in differentiating GBMs from aerobic abscesses was compared.

**RESULTS**

Means and standards deviation of maximum Cho/Cr, Cho/NAA, LL/Cr -n, Cho/Cho-n, minimum Cr/Cr-n and NAA/NAA-n ratios were 3.38 ± 1.09, 3.88 ± 2.13, 2.72 ± 1.45, 1.98 ± 0.53, 0.53 ± 0.16 and 0.44 ± 0.09, respectively, in the GBMs, and 1.77 ± 0.49, 1.48 ± 0.51, 2.11 ± 0.67, 0.81 ± 0.21, 0.48 ± 0.2 and 0.5 ± 0.15, respectively, in the aerobic abscesses. Significant differences were found in the maximum Cho/Cr ($P = .001$), Cho/NAA ($P = .006$), and Cho/Cho-n ratios ($P < .001$) between abscesses and GBMs. Diagnostic accuracy was higher by Cho/Cho-n ratio than Cho/Cr and Cho/NAA ratios (93.3% versus 86.7% and 76.7%).

**CONCLUSION**

Metabolite ratios, maximum Cho/Cho-n, Cho/Cr and Cho/NAA ratios, of contrast-enhancing rim were significantly different and useful in differentiating aerobic abscesses from GBMs by MRSI. Diagnostic accuracy was higher by Cho/Cho-n ratio than Cho/Cr and Cho/NAA ratios.

**Paper 164 Starting at 11:46 AM, Ending at 11:54 AM**

**CT Perfusion of Intracranial Tuberculomas**

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**PURPOSE**

Tuberculomas constitute about 5-40% of all intracranial space-occupying lesions. Understanding the pathophysiology leads to better clinical management. Our purpose was to study perfusion characteristics of intracranial tuberculomas and analyze changes with antitubercular treatment.

**MATERIALS & METHODS**

Cross-sectional study: Patients with solitary supratentorial tuberculosis: Treatment naïve ($n = 9$), receiving antitubercular treatment (ATT) ($n = 9$). Prospective longitudinal study: Treatment naïve tuberculosis ($n = 4$) were followed up after ATT at monthly interval till resolution. CT perfusion was done using a multidetector CT. Images were processed on a Siemens MV 300 workstation. Perfusion parameters relative cerebral blood flow (rCBF), relative cerebral blood volume (rCBV) and relative time to peak (rTTP) were obtained. Statistics: Mean and standard deviations of these parameters were calculated. Paired Student t test was performed to obtain statistical significance ($p$ value of less than 0.05) between two groups.

**RESULTS**

Relative cerebral blood flow and rCBV ($p = 0.018$ and $p = 0.005$) was low in group not on ATT as compared to group on ATT; Tuberculomas on antitubercular treatment of more than 6 months showed reduced rCBF and rCBV ($p = 0.01$ and $p = 0.00$) compared to those on treatment for less than 2 months. On follow up tuberculomas showed initial increase in the rCBF and rCBV in the first 2 months and declined to reach the normal level at resolution.
CONCLUSION

Tuberculomas show a low perfusion before treatment and with treatment the perfusion increase and decline with healing. The findings of this study suggest that serial perfusion profiles of tuberculomas on treatment could possibly be seen as surrogate markers of response to treatment.

KEY WORDS: CT perfusion, tuberculoma

Paper 165 Starting at 11:54 AM, Ending at 11:59 AM
Advanced MR Imaging of Central Nervous System Whipple's Disease: Diffusion, Perfusion, and Spectroscopy

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'Montefiore Medical Center/Albert Einstein College of Medicine, Bronx, NY, 'New York University Medical Center, New York, NY

PURPOSE

To present conventional imaging, MR perfusion and spectroscopy in a patient with recurrent and resistant CNS Whipple's disease. To describe new imaging findings and to review published imaging findings of this entity.

CASE REPORT

A 56-year-old woman presented with memory loss, language deficits and inappropriate sexual behavior. The patient underwent partial right temporal lobe resection for intracranial lesions seen on MRI. Pathology demonstrated CNS Whipple’s disease. Of note, intestinal biopsy at that time was negative. The patient improved with intravenous Ceftriaxone followed by oral Trimethoprim/Sulfamethoxazole. This was followed by oral Trimethoprim/Sulfamethoxazole. This was negative. The patient improved with intravenous Ceftriaxone and continued and plasmapheresis initiated. After multiple

IMAGING FINDINGS

Brain MRI at time of original presentation demonstrated bilateral mesial temporal enhancing masses. CT showed stippled calcifications associated with the right temporal lesion. Follow-up MRI at 2 months, after inadvertant discontinuation of oral antibiotics and re-presentation with right hemiparesis, demonstrated overall decrease in size of left temporal lobe abnormality; however, there was interval increase in size of focal restricted diffusion in the left posterior limb of the internal capsule. After reinstituting intravenous Ceftriaxone with a poor clinical response, repeat MRI showed an increase in the size of the diffusion abnormality. MR perfusion performed at that time demonstrated no hyperperfusion. MR spectroscopy demonstrated moderate elevation in Cho and decrease in NAA.

SUMMARY

We report a case of recurrent and resistant CNS Whipple’s disease after early treatment withdrawal and the imaging findings on conventional CT and MR, as well as perfusion-weighted MR imaging and MR spectroscopy. Many of the findings have not been reported previously. Specifically, calcifications can be seen in Whipple’s disease of the brain and may represent granuloma formation which previously has been described pathologically in lymph nodes and bowel. In addition, restricted diffusion best corresponded to the patient’s clinical status and may indicate areas of active infection. Diffusion-weighted imaging could be useful in following response to therapy in these patients. MR perfusion and spectroscopy can assist in differentiation from high-grade neoplasm. Review of published case reports reveals conventional MRI findings to be variable and nonspecific. MRI techniques, including MRS, diffusion-weighted imaging, and MR perfusion may aid in the diagnosis of CNS Whipple’s disease.

KEY WORDS: Whipples, infection, imaging

Paper 166 Starting at 11:59 AM, Ending at 12:04 PM
MR Imaging Findings in a Recent Case of Human Rabies

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Mayo Clinic
Rochester, MN

PURPOSE

Review the imaging findings of a well documented case of human rabies.

CASE REPORT

A 46-year-old married male without significant past medical history developed paresthesias/pain, first localizing to his right hand, with progression over the course of 10 days to paresthesias and weakness in both arms and paresthesias of the left face. Outpatient work up included a brain and cervical spine MRI which demonstrated abnormal increased T2 signal in the brain stem and central cervical cord with slight cord expansion. The patient rapidly deteriorated and was admitted to an outside hospital ICU with bilateral lower extremity paralysis. A tracheostomy was performed for insufficient respiratory drive. High dose steroids were initiated for a presumed diagnosis of demyelinating disease or transverse myelitis. Despite treatment, the patient continued to deteriorate and 9 days after admission the patient was comatose. Extensive serum and CSF analysis were negative except for slight CSF leukocytosis and an elevated CSF protein level. The patient was transferred to a tertiary care center for further evaluation/treatment. High dose steroids were continued and plasmapheresis initiated. After multiple
Imaging Findings
Symmetric increased T2 signal within the caudate heads, inferior basal ganglia, hypothalamus and medial temporal lobes bilaterally. Symmetric increased T2 signal in the pons, medulla, cervical spine, and corticospinal tracts. The signal within the spinal cord predominately involves the central gray matter. Subtle leptomeningeal enhancement intracranially and along the cervical spinal cord.

Summary
Human rabies is a rare and devastating viral infection of the peripheral and central nervous system typically resulting from an animal bite. Until recently, human rabies infections diagnosed after symptom onset have proved universally fatal, making imaging findings interesting but essentially noncontributory to the clinical outcome. With a recent case report of a rabies survivor with aggressive treatment following disease onset, familiarity with the MR appearance of rabies hopefully can lead to a more timely diagnosis.

Keywords: Human rabies, MRI

Conclusion
The clinical reports reliably alerted clinicians to the presence of significant ischemic white matter disease. White matter hyperintensities grade 4 or greater has been associated with a 42% increased risk for new infarct within 5 years and over 98% of the clinical reports for subjects in this high risk group included a mention of white matter abnormality. On the other hand, the specific terminology used to describe the severity of WMH in the clinical reports was varied and adopting a more uniform scale using terms such as mild,
moderate, severe may be more helpful to clinicians than descriptions such as “scattered areas” which had lower specificity when correlated with WMH grade.

**KEY WORDS:** Leukoaraiosis, MRI, reporting

**Paper 168 Starting at 12:12 PM, Ending at 12:20 PM**

Automated Bayesian Segmentation of Microvascular White Matter Lesions

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¹University of Pennsylvania, Philadelphia, PA, ²University of California Irvine, Irvine, CA

**PURPOSE**

To determine whether an automated Bayesian method for brain-lesion detection can accurately segment microvascular white matter lesions.

**MATERIALS & METHODS**

We designed a Bayesian algorithm that fuses spatial and signal-intensity information about normal gray matter (GM), white matter (WM), cerebrospinal fluid (CSF) and about WM T2-hyperintense microvascular lesions. To test the feasibility of completely automating the lesion-segmentation process, we obtained T1, T2, spin-density (SD) and FLAIR images for 42 subjects from the Action to Control Cardiovascular Risk in Diabetees (ACCORD) study (1), which were acquired at one of two sites: Minneapolis MN, at which a 1.5T Philips Intera scanner was used, and Winston-Salem, NC, at which a 1.5T General Electric LX scanner was used. MR hardware and sequence parameters for the two sites are shown in Table 1. To characterize lesions, a neuroradiologist (RNB) used a workstation to segment lesions for 42 subjects, using any combination of the four sequences available for each subject. Criteria for lesion identification were similar to those used in the Cardiovascular Health Study (2). We performed intensity normalization by matching the histograms of each subject’s images to those of a selected target subject, to standardize signal intensities for each sequence across subjects. We used a nonlinear warping algorithm (3) to register each sequence (and thus all sequences) to the Montreal Neurological Institute atlas (4). To parameterize our software for GM, WM, CSF and lesions, we computed from a training set prior probabilities, a multivariate Gaussian signal-intensity distribution in 4D sequence space, and a voxel-wise histogram of spatial probabilities. We assessed our algorithm’s lesion-segmentation abilities. We assessed our algorithm’s lesion-segmentation abilities.

**RESULTS**

The area under the ROC curve for the LOOCV experiment was 0.96. We found minimal differences in classification accuracies whether we trained and tested using subjects from the same site (0.97), or from different sites (0.94).

**Table 1: MR hardware and sequence parameters for the two sites**

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Sequence</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>FOV (mm)</th>
<th>Voxel Size (mm)</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>FOV (mm)</th>
<th>Voxel Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minneapolis/Phillips</td>
<td>T1</td>
<td>21</td>
<td>8</td>
<td>240</td>
<td>0.9375 x 0.9375 x 1.5</td>
<td>24</td>
<td>8</td>
<td>240</td>
<td>0.9375 x 0.9375 x 1.5</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>2630</td>
<td>100</td>
<td>240</td>
<td>0.9375 x 0.9375 x 3.0</td>
<td>3200</td>
<td>122</td>
<td>240</td>
<td>0.9375 x 0.9375 x 3.0</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>2630</td>
<td>27</td>
<td>240</td>
<td>0.9375 x 0.9375 x 3.0</td>
<td>3200</td>
<td>30</td>
<td>240</td>
<td>0.9375 x 0.9375 x 3.0</td>
</tr>
<tr>
<td></td>
<td>FLAIR</td>
<td>8800</td>
<td>100</td>
<td>240</td>
<td>0.9375 x 0.9375 x 3.0</td>
<td>6002</td>
<td>100</td>
<td>240</td>
<td>0.9375 x 0.9375 x 3.0</td>
</tr>
</tbody>
</table>

**CONCLUSION**

A Bayesian classifier that takes into account the relative volumes, signal intensities, and spatial distributions of normal structures and lesions can accurately segment lesions in new multisequence MR images, even if the new images have been acquired at a different site, with different MR hardware.

**REFERENCES**

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2. http://www.ajnr.org/cgi/content/abstract/15/9/1625
3. http://dx.doi.org/10.1109/TMI.2002.803111

**KEY WORDS:** Segmentation, microvascular, white matter

**Paper 169 Starting at 12:20 PM, Ending at 12:25 PM**

MR Imaging Findings of Lyme Encephalopathy and their Correlation with Clinical Presentation, PCR Analysis, and Antibody Titers

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**PURPOSE**

To review the pathophysiology of Lyme disease, discuss the current controversy regarding the diagnosis, explore the role of MRI within the diagnostic algorithm, and contribute to the ongoing debate our experience with a series of patients referred for MRI evaluation of neurologic symptoms presumptively related to Lyme encephalopathy.

**CASE REPORT**

Primary and follow-up MRI studies from a series of patients referred for imaging evaluation of Lyme encephalopathy were read by the neuroradiologist, and the cases were reviewed comprehensively with a neurologist, and infectious disease specialist. The imaging findings were correlated with the patient’s clinical course, CSF markers for the disease, and response to specific treatment.

**IMAGING FINDINGS**

Lyme encephalopathy is a difficult diagnosis for the clinician to make. Sensitivity and specificity of CSF markers for the disease are notoriously low and vary widely according to the processing facility. MR imaging findings attributed to Lyme disease are similar to those defined for MS and other demyelinating disorders. Despite a putatively definitive article recently published in one of the major medical journals, the topic of Lyme disease remains nebulous and controversial. Our experience (spanning many years within an endemic area) with MRI findings of chronic Lyme encephalopathy is instructive and challenges the radiology community to take an active role in the ongoing discussion.
SUMMARY
Controversy regarding diagnosis and treatment of chronic Lyme encephalopathy rages in the scientific literature and lay press. We present 10 cases referred for MRI evaluation of Lyme encephalopathy. The viewer will consider if MRI helped with the diagnosis and how seriously it should be considered in the differential diagnosis of nonspecific white matter T2 hyperintensities. Imprecision of the final diagnosis in each case challenges the sensitivity and specificity of MRI for Lyme encephalopathy.

KEY WORDS: Lyme, multiple sclerosis, shimkin

tuesday Morning
10:45 AM – 12:30 PM
Room 208/209

(20c) ADULT BRAIN: Functional II
(Scientific Papers 170 – 182)

See also Parallel Sessions
(20a) INTERVENTIONAL: Aneurysms I
(20b) ADULT BRAIN: Trauma, Inflammation & Ischemic Disease/Excerpta
(20d) PEDIATRIC: Functional Imaging

Moderators: Scott H. Faro, MD
David J. Mikulis, MD

Paper 170 Starting at 10:45 AM, Ending at 10:53 AM
Correlation between Preoperative Functional MR Imaging Evaluation of the Supplemental Motor Area Language Area: Immediate Postoperative Deficits and Recovery of Language Function

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Memorial Sloan-Kettering Cancer Center
New York, NY

PURPOSE
Recent research shows that the supplemental motor area (SMA) is involved in higher order language processing, though the precise mechanisms and circuits have yet to be elucidated fully. The purpose of this study is to better understand the relationship between SMA lateralization on fMRI, surgical resection, immediate postoperative deficits and recovery of language function.

MATERIALS & METHODS
Seven 100% right-handed patients with frontal lobe lesions involving the SMA underwent presurgical fMRI and resection of the lesion including all or part of the expected location of the ipsilateral SMA. Functional MRI paradigms (verb generation, category generation, and phonemic fluency) for localization of the language centers were performed. Language/speech assessment was made based on formal neuropsychologic testing before and after surgery. Functional MRI was performed on 1.5 T or 3 T GE scanners using echo-planar imaging (TR = 4000, TE = 40). Functional activity was generated using AFNI, cross-correlation analysis at p < 0.001. Bilateral SMA activation was quantified with volumetric ROI. Supplemental motor area Laterality Index = (Left SMA activity - Right SMA activity)/(Left SMA activity + Right SMA activity).

RESULTS
All seven patients showed left-sided dominant Broca’s and Wernicke’s areas. Six showed bilateral/midline (non lateralizing) Supplemental motor area activation, and resection of left-sided tumors (with at least partial resection of the fMRI defined SMA with sparing of the ipsilateral Broca’s and Wernicke’s areas) in five of these patients resulted in temporary postoperative speech deficits ranging from expressive language impairment to mutism and/or global aphasia, with significant recovery of speech function with 6 weeks in all cases. The sixth patient with a nonlateralizing SMA had a right frontal lobe tumor resected and suffered no language impairment. The patient with right lateralizing fMRI SMA activity had a left-sided tumor resected and exhibited no impairment in language following surgery.

CONCLUSION
Tumor resection which included the fMRI defined SMA ipsilateral to Broca’s/Wernicke’s areas led to language deficits. Patients with resection of tumor with contralateral fMRI SMA lateralization or with the tumor contralateral to the dominant Broca’s/Wernicke’s areas showed no speech deficits. These findings as well as language function recovery in all cases can be used in preoperative neurosurgical planning and counseling. Assessment of whether SMA function migrated to the contralateral side or to another center within the ipsilateral brain should be investigated further.

KEY WORDS: Glioma, fMRI, language
Functional MR Imaging of Reorganization of Language Function over Time in Patients with Brain Tumors

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New York, NY

**Purpose**
Recent studies in brain tumor patients have demonstrated a capacity for cortical reorganization of function previously performed by damaged areas (1). However, these studies infer reorganization based on a single point in time. The purpose of this longitudinal study is to measure the dynamic changes in language organization in brain tumor patients over time in an effort to better understand the mechanism underlying cortical reorganization.

**Materials & Methods**
Five right-handed patients with low-grade gliomas directly adjacent to the frontal language areas (Broca’s area), were studied prospectively. Three block paradigms were applied: 1) verb generation to specific nouns, 2) category generation, and 3) phonemic fluency (word generation to given letters). The tasks were performed silently, avoiding mouth and tongue movement. Three fMRI scans were acquired (1 presurgically and two postoperative follow-up scans at 3-6 month intervals) using the same functional paradigms. Formal neuropsychologic evaluations were paired with each fMRI examination. The functional studies were performed on a 1.5 T GE using echo-planar imaging (TR = 4000 ms; TE = 40 ms). The reconstructed fMRI data were aligned using a 3D rigid-body registration. Functional activity was generated using a cross-correlation analysis at \( p < 0.001 \). Broca’s area ROI measurements were used to determine the language laterality index (LI), where LI = (L-R)/(L+R).

**Results**
Four of 5 patients qualitatively demonstrated increased right hemispheric compensation in either Broca’s Area, Wernicke’s Area or both on the follow-up fMRI scans. Figure 1A: presurgical baseline fMRI. B: 3 months postsurgery. C: 6 months postsurgery. Two postoperative follow-up fMRI scans figure B) and C) demonstrated progressively increasing fMRI activation in Broca’s area in the right hemisphere (contralateral to the tumor). Presurgical fMRI indicated the expected left-hemispheric dominance for language. This was confirmed intraoperatively with electrocorticography.

**Conclusion**
Current results support the interhemispheric compensation model seen in stroke patients. Whether such functional compensation is clinically meaningful (i.e., enables the surgeon to be more aggressive in the left dominant hemisphere) is yet unknown. However, there is evidence using transcranial magnetic stimulation (TMS) to suggest that codominance or right dominance on fMRI does predict the extent of disruption of speech in the right hemisphere with TMS (2). Whether or not tumor invasion of primary language centers can potentially alter functional assessments made at these sites is an important question that could impact presurgical planning efforts and needs to be further investigated.

**References**

**Key Words:** fMRI, glioma, language

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Functional MR Imaging of Patients Undergoing Resection of Left Frontal Lobe Tumors: Impact on Broca Area

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**Purpose**
To reduce aphasia following resection of left frontal lobe tumors we preoperatively mapped language activation areas with fMRI and white matter fibers with diffusion tensor tractography (DTT).
RESULTS

Language areas were visible on activation maps (black area on Fig. 1A). Although all 10 volunteers were right-handed, volunteer had LI=0.237, indicating a right language dominant hemisphere. White matter tractography in healthy volunteers showed known anatomy. In 12 of 15 patients with glioma (n=13), germinoma (n=1), cavernoma (n=1), relationship of Broca area and precentral motor area to the frontal lobe tumor was identified allowing preoperative neorosurgical planning to minimize language and motor disruption. All 12 patients had left language dominant hemisphere with LI≥0.01. The other three patients’ activation maps were corrupted by motion. Diffusion tensor images were successful in 14 patients, corrupted by motion in one patient. Directionally encoded images showed disruption of the left arcuate fasciculus in two patients (Fig. 1B), deviation/deformation in seven cases and unaffected in the remaining five cases. Preoperative review of language mapping and white matter tracts of DTT influenced the surgical approach in all 12 patients for whom it was available. Postoperatively, one patient died and one was lost to follow up. The remaining 13 patients showed no tumor recurrence at 3-9 months follow up. No patient language function deteriorated, though two patients with mild aphasia preoperatively did not improve: one with partial disruption of the anterior left arcuate fasciculus and the other with obliteration of the entire arcuate fasciculus by glioma. This compares favorably with the historical 30% incidence of aphasia postresection of left frontal lobe tumors.

CONCLUSION

The combination of fMRI and DTT is helpful for identifying the relationship of brain tumors to language cortex and white matter fibers for planning surgical resections that spare language function.

KEY WORDS: fMRI, tractography, neoplasm

Paper 173 Starting at 11:09 AM, Ending at 11:17 AM

How Different Brain Pathologies Influence Language Plasticity in the Brain: Functional MR Imaging Study

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PURPOSE

An atypical interhemispherical organization of cortical language areas has been demonstrated using PET and fMRI in several pathologic conditions affecting the brain, such as tumors, epilepsy and stroke (1, 2). A higher degree of unusual language lateralization was found in these patients compared to controls. The aim of this study was to evaluate the correlation between different neurologic diseases and language reorganization/plasticity.

MATERIALS & METHODS

We enrolled 84 consecutive right-handed neurosurgical patients: 24 with refractory epilepsy (13 men, 11 women; age 21-53 years), 47 with brain gliomas (30 men, 17 women; age: 23-75 years), 13 with brain cavernoma (8 men, 5 women; age: 21-64 years). An age-matched group of 13 right-handed healthy controls also entered the study. All patients underwent fMRI while performing word and verb generation tasks. The number of active voxels was calculated for the right and left hemisphere and laterality indices were calculated \[LI=(L-R)/(L+R)\]. Differences in lateralization were evaluated between tumor, epilepsy, cavernoma and control groups used paired t-test \(p < 0.01\). Differences in lateralization were correlated with the hemispherical distribution (left or right), histopathology, size and site of the lesion and its spatial relationship to language structures of the cerebral cortex.

RESULTS

Epilepsy was lesional (19/24) and cryptogenetic (5/24) and the focus was in the right (14/24) and left hemisphere (10/24). Tumors were high (28/47) and low-grade (19/47) gliomas of the left (39/47) and the right (8/47) hemisphere and ranged in volume from 587 to 141,000 cu mm. Language was significantly less lateralized to the dominant (left) hemisphere in patients with a left hemisphere tumor or epilepsy, compared to controls. Whereas, differences were not observed in cavernoma and right hemisphere tumor or epilepsy, compared to controls. In brain tumors, language reorganization to the nondominant hemisphere directly correlated with malignancy, large volume and close spatial relationship \((p < 0.019, p < 0.0061, p < 0.02\), respectively) (Fig. 1).
CONCLUSION
The side and type of pathology influenced language plasticity. Left hemisphere gliomas and epilepsy altered to a greater extent the normal lateralization of language. Larger and malignant left hemisphere tumors growing in eloquent cortical regions for speech were those capable of strongly influencing language lateralization.

REFERENCES

KEY WORDS: Language, plasticity, fMRI

Paper 174 Starting at 11:17 AM, Ending at 11:25 AM
New Method to Quantify Language Lateralization with Functional MR Imaging Using Whole Brain Analysis

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PURPOSE
Surgery is often the only effective treatment for patients with medically intractable epilepsy. Benefits of surgery must be balanced by potential disruption of various eloquent functions. To this end, language localization and lateralization is essential. Wada test is considered a standard technique to lateralize language. However, its invasive nature is associated with complications. Functional MRI provides a noninvasive alternative that has been shown to correlate with Wada results. For clinical fMRI interpretation, the previously reported simple laterality indexes (LI) are highly dependent on a predetermined threshold. We report an alternative method of measuring language lateralization index in fMRI that does not require the use of a predetermined threshold.

MATERIALS & METHODS
Twenty-eight epilepsy/brain tumor patients with Wada and fMRI testing for language were studied retrospectively. Functional MRI was performed at 3 T with one motor and three language paradigms. Student t-score maps were separated for each cerebral hemisphere, and whole-hemispheric histogram distributions of t-scores were generated. These were subtracted from control histograms derived from Gaussian fits to the most dominant portions of t-score distributions. Deviations were greatest in the tails and reflected paradigm-related activity, whose small differences could be efficiently weighted by using a log scale. These departures were scored and collected from all patients to produce clinically useful scatter plots.

RESULTS
Paradigm-related departures from the expected t-score distribution are visualized easily, whose left-right asymmetry indicates lateralization. These departures are scored easily, and a scatter plot of right vs left hemispheric language scores from all patients with Wada tests is shown in the attached figure. Points above and below the diagonal line represent left and right dominance, respectively. This behavior correlates well with Wada tests as indicated by point color: red (Wada left), blue (Wada right), and yellow (Wada bilateral). A single lateralization index for these fMRI results can be computed, which correlates to the Wada lateralization index with a coefficient of $r^2=0.52$. Motor paradigms are also well visualized on other scatter plots, lying along the diagonal as expected.

CONCLUSION
We present a new method to quantify global fMRI activation in the cerebral hemispheres in an objective and automated way, which highly correlates with Wada results during language paradigms. Unlike previous measures of laterality index, this method does not require input of an a priori threshold. Also, this method is visually sensitive to small activations, and occasionally can reveal language lateralization when a reader viewing standard planar images reports no significant activation.

KEY WORDS: fMRI language lateralization, laterality index, medically intractable epilepsy
Cerebellar Involvement in Canonical Intrinsicly Connected Brain Networks

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Purpose
A growing number of anatomical, clinical and functional imaging data have strongly implicated the cerebellar system in nonmotor functions. Therefore, we sought explicitly to explore the role of the cerebellum in several previously defined intrinsic connectivity networks (ICNs) involved in canonical cognitive functions such as memory, executive function and salience detection, using resting-state functional connectivity (1-3). This method allows for the identification of ICNs based on temporal correlations in low-frequency oscillations (0.01-0.1 Hz) of the blood-oxygen level dependent signal. It was assumed that cognitive and affective ICNs would incorporate several specific cerebellar clusters distinct from the well known cerebellar motor areas, and that an anatomo-functional parcellation of the cognitive neocerebellum could be precisely drawn.

Materials & Methods
Resting-state data encompassing the whole encephalon and cerebellum of 15 healthy volunteers were acquired with a 3 T scanner. Postprocessing of the T2*-weighted gradient-echo planar images mainly and successively comprised: motion correction, temporal filtering, independent component analysis of the resting-state data for each volunteer, application of an unbiased template-matching procedure to identify the ICNs amongst the individual ICA maps [the executive control network, the salience network (dealing with interoceptive and emotional informations), the default mode network (dealing with episodic and semantic memories, stream of consciousness, self-reflection) and the motor network], and group analysis.

Results
1. The neocerebellum (crus1 and crus 2) is poorly connected to motor and premotor cortical areas, contrary to lobes V-VI; 2. The major part of the neocerebellum, likely in conjunction with pontine nuclei, belongs to the executive network including the dorsolateral frontal and parietal neocortices; 3. The right crus 2, the vermal lobules V-VI and the right lobe IX take part in the default mode network comprising the anterior and posterior cingulate cortices; 4. The rostral vermis of lobules V-VI and narrow parts of crus 1 and crus 2 are incorporated in the salience network centered on dorsal anterior cingulate and orbital frontoinsular cortices; 5. The cerebellar regions linked to these specific ICNs display little to no anatomical overlap; and 6. No clusters were found within the dentate nuclei probably because our cortico-cerebellar clusters may reflect input channels.

Conclusion
The most phylogenetically recent part of the human cerebellum, particularly crus 1 and crus 2, quite exclusively contributes to parallel cortico-cerebellar loops involved in executive control, salience detection, and episodic memory/self-reflection, whereas older cerebellar regions, such as the anterior lobe and the tonsilla, are included less extensively in these ICNs. The most prominent part of the neocerebellum participates in the executive network coping with selection and maintenance in working memory of relevant multimodal information.

References

Key Words: Functional connectivity, cerebellum, cognition

Brain Functional MR Imaging of Patients with Overactive Bladder Treated with Anticholinergic Drugs

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Purpose
Overactive bladder (OAB) leads to a decreased quality of life. The purpose of this study is to determine whether there are central nervous system (CNS) differences in modulating bladder function that contribute to, or are themselves the cause of the symptoms in OAB patients. We further investigated the pharmacologic fMRI changes using anticholinergic treatment of these patients with OAB. To our knowledge the mechanisms of anticholinergic drug induced changes of OAB symptoms at sites outside of the bladder have not been investigated using fMRI.

Materials & Methods
Twenty female OAB patients were recruited. The primary eligibility criteria to recruit the patients were: female ≥ 18 years of age with symptoms for > 6 months, who experienced > 8 voids per day. Patients stopped anticholinergic medications for a 2-week washout period. Patients were catheterized for filling and emptying. Baseline MRI was performed prior to filling. On sensation of a strong desire to void, filling was stopped and fMRI was performed. The bladder was drained for rescanning. This fill/drain cycle was repeated five times. Patients were randomized to receive tolterodine or placebo for 1 month, followed by a second fMRI session. Statistical parametric maps displayed a visual representation of regions of the brain that showed statistically significant increased activity in the full versus drain conditions in the pre and posttreatment groups.

Results
In the pretreatment group, our results show 14 statistically significant (p < 0.01) brain regions of increased activity induced by the sensation of fullness. Two different regions of significance were identified in the posttreatment and placebo
groups. The two statistically significant regions seen are parietal lobe (precuneus) and parietal lobe (postcentral gyrus) in right and left hemisphere, respectively for the tolterodine group. In the placebo group these were within the cerebellum (anterior lobe, culmen). Less urgency induced brain activation after treatment in both the active and placebo treatments also was seen.

**Conclusion**

To our knowledge this is the first study to inquire about the pharmacologic effects in CNS of OAB patients using fMRI. In general, there appears to be less urgency induced brain activation after treatment in both the active and placebo treatments.

**Key Words:** fMRI, overactive bladder

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**Paper 177 Starting at 11:41 AM, Ending at 11:49 AM**

**Comparative Functional MR Imaging Evaluation of Primary Writing Tremor, Writers Cramp and Healthy Controls**

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**Purpose**

The precise pathophysiology of primary writing disorders of primary writing tremor (PWT) and writers cramp (WC) is yet unknown. Functional MR imaging with the task of signing on paper, was used to compare the cerebral activation pattern in patients of PWT, WC and healthy volunteers.

**Materials & Methods**

Six subjects with PWT, three with WC and six healthy volunteers were examined using a 1.5 T scanner. The paradigm consisted of alternating periods of 40 seconds (ten BOLD EPI acquisitions) each at rest and while signing on paper using the dominant right hand. Three such sets were acquired. Entire brain was covered. SPM99 analysis was done.

**Results**

Primary and supplementary motor areas show over activation in patients of PWT and under activation in patients of WC as compared to healthy volunteers. The cingulate motor area shows under activation in patients of PWT and over activation in patients of WC as compared to healthy volunteers. While cerebellar activity is reduced in both WC and PWT, it is much more so in WC.

**Conclusion**

1. Cerebral activation patterns of PWT and WC are distinct from each other and different from healthy volunteers. 2. There is over activation of primary and supplementary motor areas and under activation of cingulate motor area in PWT. 3. There is under activation of primary and supplementary motor areas and over activation of cingulate motor area in WC. 4. There is under activation of cerebellum in both PWT and WC. 5. Proprioception/cerebellar dysfunction may be there in addition to motor dysfunction in the pathophysiology of these disorders.

**Key Words:** fMRI, primary writing tremor, writers cramp

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**Paper 178 Starting at 11:49 AM, Ending at 11:57 AM**

**Disconnection of Inhibitory Functional Connectivity of Amygdala after Violent Game Playing**

Wang, Y. · Mathews, V. P. · Kalnin, A. J. · Mosier, K. M. · Dunn, D. W. · Saykin, A. J. · Kronenberger, W. G.

Indiana University School of Medicine

**Purpose**

In order to assess the short-term effect of video game playing on brain function, an fMRI study of an emotional Stroop task was carried out immediately after playing a violent or nonviolent video game.

**Materials & Methods**

Forty-four healthy adolescents were assigned randomly into two experimental groups, 22 per group. These two groups did not differ in gender, age or IQ. Immediately before the fMRI scan, one group played a violent video game for half hour, while another group played a nonviolent video game. All subjects were imaged using conventional BOLD fMRI techniques on a 3 T MR system while performing an event-related emotional Stroop task. Subjects were asked to press buttons responding to the color of visually presented words while ignoring the meaning of each word. Words indicating violent actions were interspersed among the nonviolent action words in a pseudorandom order.

**Results**

Behavioral data showed no statistically significant group differences in accuracy or reaction time for either violent or nonviolent words. Both groups showed increased activation in the left ventrolateral PFC during violent compared to nonviolent words. In addition, the group playing the violent game showed increased activity in the right amygdala, where the group playing the nonviolent game demonstrated decreased activity of the right amygdala and increased activity in the medial PFC. Psychophysologic interaction analysis revealed the negative coupling between right amygdala and medial PFC in the nonviolent game group. By contrast, no significant functional connectivity between right amygdala and medial PFC was found in the violent game group.

**Conclusion**

Violent video game playing may induce a differential pattern of brain activation in response to affective stimuli including diminished functional integration of an inhibitory network involving the amygdala and frontal circuitry.

**Key Words:** Functional connectivity, amygdala, violence
Functional MR Imaging Study of Brain Activation in Patients with Optic Neuritis

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**Purpose**
To study brain activation patterns in patients with monocular or binocular optic neuritis. To study the activation patterns in those patients who have recovered following treatment.

**Materials & Methods**
The prospective study included seven patients with bilateral and eight patients with unilateral (4 in each eye) optic neuritis who underwent clinical, electrophysiologic, ophthalmologic work up and were confirmed cases of optic neuritis and seven normal volunteers. MR imaging was performed on a 1.5 T magnet. Functional MRI paradigm included a visual stimulus of “reversing checkerboard” alternating at a frequency of 8 Hz which was projected to the subject in the active phase and a dark screen in the rest phase. Patients with unilateral optic neuritis were tested for each eye separately with one eye covered by a patch whereas patients with bilateral optic neuritis were presented a visual stimulus with both eyes open. Visual evoked potentials (VEP) were done in all the patients and correlated with fMRI activity. Individual and group analysis of the data was done and activation at significance levels of \( p < 0.05 \) corrected were analyzed.

**Results**
Consistent activation was noted in bilateral primary visual areas (Brodmann areas 17 and 18) in normal volunteers with monocular or binocular visual stimulation. Significant decrease in activation volume within the visual cortex was noted in both unilateral and bilateral optic neuritis patients when compared with normal volunteers. Stimulation of the unaffected eye in patients with bilateral optic neuritis showed reduced activation compared to normal volunteers but of a similar pattern and involved the primary visual cortex. Stimulation of affected eye in patients who had recovered showed partial recovery of activation in the primary visual cortex. Visual activation patterns correlated with abnormalities in visual evoked responses in the form of increased latency in most of the patients.

**Conclusion**
Functional MRI is sensitive to changes in cortical response to visual stimuli during acute optic neuritis. Significant and quantifiable decrease in activation in the primary visual cortex is noted in patients with optic neuritis compared to normal volunteers. Visual activation patterns correlate with abnormalities noted in visual evoked responses. Recovery from optic neuritis is evident in the restoration of activation patterns in the primary visual cortex.

**Key Words:** fMRI, optic neuritis
CONCLUSION
Two-dimensional rFOV DWEPI allows quantitative analysis of diffusion parameters in human optic nerve. Results demonstrate increased radial diffusivity in MS/ON patients. Axial diffusivity is unchanged. This method may facilitate sensitive and specific detection of demyelination in optic nerve. Additionally, quantitative measurement may allow evaluation of therapy response.

Support: NIH grants R01 HL 48223, HL 57990 and EY015181, Cummings Foundation, Mar golis Foundation, Siemens Medical Solutions.

KEY WORDS: Multiple sclerosis, optic nerve, DTI

Paper 181 Starting at 12:13 PM, Ending at 12:21 PM
Functional Assessment of Patients with Optic Neuritis before and after Treatment at 3 T
Nguyen, T. H. · Stievenart, J. L. · Bellinger, L. · Abanou, A. · Le Gargasson, J. F. · Cabanis, E. A.
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PURPOSE
Evaluation of the recovering visual cortical response with 3 T functional MR imaging (fMRI) at diagnosis and following treatment of inflammatory optic neuritis.

MATERIALS & METHODS
We have explored 15 patients (11 female, 4 male, aged 19 to 35 years old) presenting with a rapid visual acuity loss, with a clinical appearance of optic neuritis. Anatomical and fMRI at 3 T was performed at day 0, then 3 months after steroid therapy (M3). Functional MRI included two monocular visual stimulations, referring to a sequential paradigm alternating rest and active phases, with still and flickering black and white checkerboards (15 angular minutes of spatial resolution and 4 Hz of temporal frequency). Functional data were realigned onto anatomical volumes, the group statistical analysis was obtained using FSL 4.0 software (Oxford University) (p < 0.05).

RESULTS
At day 0, anatomical imaging showed a swelling of the affected optic nerves, with an increase of the diameter and T2 hypersignal. The inflammation was confined to the orbital portion of the nerve in four patients, the portion within the optic canal in eight patients, the cisternal portion in three patients, with extension to the chiasm in two patients. Functional group analysis demonstrated a restricted response in both occipital poles (V1 area dedicated to central vision), following stimulation of the affected optic nerve, when compared to that of the contralateral normal eye. Cortical response also was noted in parietal and frontal areas, in the cuneus and the lingual gyrus. At M3, all patients recovered a nearly normal visual acuity, from 6/7.5 to 6/6 on Snellen charts. The nerve diameter has become normal although T2 hypersignal persisted. The extent of the hypersignal remained unchanged in six patients and has regressed in nine patients. Cortical response in central V1 became comparable for both eyes, while less activity was noted in secondary visual areas. At day 0 and M3, bilateral responses in V5 were comparable for both eyes, before and after treatment.

CONCLUSION
At M3, a persistent T2 hypersignal appeared in contrast with functional findings; with a V1 response recovering in accordance with a normal or subnormal visual acuity. During the acute phase of the inflammation of the optic nerve, accentuated cortical response in secondary and associative visual areas may reflect a cortical recruitment to improve visual reconstruction. The preserved response in both V5 for either affected or normal eye, before and after treatment suggested either V5 might not be affected in the inflammation process, or there might be connection between the geniculate nucleus and V5 without mediation by V1. Anatomical and functional MR imaging may be achieved in routine evaluation of optic neuritis, with a better correspondence of functional findings to clinical evolution. Functional MRI could be associated to VEP, visual field and visual acuity follow up of the optic nerve pathology.

KEY WORDS: Optic neuritis, fMRI, follow up

Paper 182 Starting at 12:21 PM, Ending at 12:26 PM
Discordant Broca’s and Wernicke’s Area Language Lateralization in the Setting of Remote Head Trauma and Epilepsy
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PURPOSE
We present the clinical and functional MRI (fMRI) features of an unusual case of right hemispheric dominant expressive language occurring in association with left dominant receptive language in an epileptic patient with a history of remote head trauma.

CASE REPORT
The patient was a 36-year-old, right-handed, Spanish and English speaking female with partial complex seizures that was being evaluated for potential left temporal lobectomy. The patient’s seizures started at the age of 4 years and were characterized by an aura of fear that would inconsistently progress to complete loss of awareness, staring, and right upper extremity posturing. Despite numerous attempted medical treatment regimens, the patient continued to experience several seizures a month and had elected to pursue surgical treatment. Also of note, the patient had suffered a traumatic closed head injury at the age of 6 years while falling down stairs. This resulted in loss of consciousness for several minutes. As part of her prior seizure evaluation, an ictal SPECT study localized to the left temporal region. Similarly, EEG data demonstrated left temporal onset of seizures. Wada testing (in English) demonstrated left hemispheric language dominance and strong support for memory structures in the left hemisphere.
**IMAGING FINDINGS**

Conventional MRI of the brain identified volume loss in the left hippocampus with subtle increased T2 signal, consistent with mesial temporal sclerosis. There was a small focus of posttraumatic encephalomalacia in the left anterior superior frontal gyrus. There was no visible encephalomalacia involving the left inferior frontal gyrus. The skull was dolichocephalic. A gadolinium bolus dynamic susceptibility perfusion study was normal. Multiple fMRI block paradigm language tasks were performed at 3 T and processed with a voxel-wise t-test. The derived activation maps were reviewed across multiple statistical thresholds. A visual sentence comprehension task in Spanish demonstrated strong BOLD activation in the right inferior frontal gyrus in the Broca’s area homologue. This task also caused prominent activation of the left Wernicke’s area. There was only scant activation in the left Broca’s area and minimal activation in the right Wernicke’s homologue. A similar visual sentence comprehension task in English also strongly activated the right Broca’s area homologue and left Wernicke’s area. There was some minimal activation of the left Broca’s area on this task. A silent word generation task in Spanish demonstrated significant activation of the right Broca’s homologue and a small amount of activation in left Wernicke’s area.

**SUMMARY**

Functional MRI demonstrated an atypical, unexpected reorganization of Broca’s area into the right hemisphere in this right-handed individual with a remote history of left frontal lobe traumatic injury. This functional language abnormality previously had escaped detection with Wada testing. Hemispheric translocation of language areas previously has been demonstrated with brain tumors. Our case demonstrates similar functional reorganization in the setting of chronic head trauma and suggests that fMRI is complementary to Wada for preoperative language evaluation in epileptic patients with a history of traumatic brain injury.

**KEY WORDS:** fMRI, language, trauma

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**Paper 183 Starting at 10:45 AM, Ending at 10:53 AM
MR Parameters for Normal Fetal Brain Development between Gestational Weeks 19 to 24**

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**PURPOSE**

The purpose of this study was to establish MR parameters for normal fetal brain development between gestational weeks (GW) 19 and 24.

**MATERIALS & METHODS**

In 64 fetuses aged between GW 19 and 24, (at least 9 fetuses in each GW) with presumed normal brain development in utero MRI was performed using a 1.5 T superconducting system and a phased array cardiac coil. On T2-weighted fast spin-echo sequences and diffusion-weighted sequences the following structures were assessed: sagittal front-occipital diameter (FOD), axial fronto-occipital diameter (axFOD), length of the corpus callosum (LCC), width of fourth ventricle (4V), width of third ventricle (3V), interhemispheric diameter (IHD), bone biparietal diameter (bBPD), cerebral biparietal diameter (cBPD), width of lateral ventricles bilaterally (LVR, LVL), anteroposterior interpulmonary diameters bilaterally (APIPD-R, APIPD-L), cranial caudal interpulmonary diameters bilaterally (CCIPD-R, CCIPD-L), and transverse cerebellar diameter (TCD). The lamination was assessed on T2- and diffusion-weighted images and detectability of ganglionic eminences was determined. Measurements of the lamina of the brain parenchyma were done at the tip of the frontal horn perpendicular to the cortical plate in this region.
RESULTS
In gestational ages between 19 and 24 weeks, continuously increasing patterns of growth were seen best in parameters that measured brain parenchyma, as opposed to those parameters measuring ventricular spaces. Linear rates of growth were seen in LCC, TCD, axFOD bilaterally. Cerebral biparietal diameter and bBPD parameters exhibited exponential growth that began to level off at the 24th week. The other parameters did not exhibit a continuous pattern of either positive or negative growth. Regarding the interopercular diameters a temporal side-difference was seen with the right operculum developing faster than the left. Ganglionic eminences were identified bilaterally in every case. In diffusion-weighted images, at least three levels of lamination (at least the ventricular/periventricular zones, subplate, and cortical plate, with inconstant proof of the intermediate zone) were clearly distinguishable in each gestational week from 19 to 24 weeks. However, the depth of each progressive layer of lamination could not be measured with any consistency.

CONCLUSION
As normal fetal brain development is characterized by growth and changes in arrangement of the brain parenchyma. In the in vivo situation histologically known changes of fetal brain development can be reproduced only partly. This makes a clear definition of age-related normal features of in vivo cerebral maturation at these ages necessary. Based on these results, deviations from normal fetal brain development will be recognizable early and accurately.

KEY WORDS: Fetal brain MRI, normal, parameters

Paper 184 Starting at 10:53 AM, Ending at 11:01 AM
Correlation of Changes in Fractional Anisotropy and Apparent Diffusion Coefficient Values during the First Year of Life
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PURPOSE
To test the hypotheses that increase in fractional anisotropy (FA) values correlates with decreases in apparent diffusion coefficient (ADC) values and that both occur in a linear manner in cerebral white matter (WM) in full-term infants during the first year of life.

MATERIALS & METHODS
Fifty-three children (35 boys) ranging in age from 0 weeks premature to 51 weeks (mean age, 22.9 weeks) underwent conventional MR imaging, diffusion imaging using three directions (b = 1,000 s/mm²) and diffusion tensor imaging with gradient encoding in six directions on a 1.5 T MR scanner. All infants had normal MR scans. Apparent diffusion coefficient and FA values were measured in the same locations in three deep WM structures [posterior limb of internal capsule (PLIC), genu and splenium of corpus callosum] and three peripheral WM regions [associational WM underlying prefrontal, posterior frontal and posterior parietal cortex] using a standard region of interest (60 ± 4 mm²). We compared (1) FA vs ADC for each region using Pearson correlations and (2) FA and ADC with age using linear regressions and also a fit to a segmented linear function of age.

RESULTS
Fractional anisotropy and ADC were better correlated in subcortical regions than in deep WM regions. Average Pearson correlation for subcortical WM was -0.829 and for deep WM was -0.747. The change of ADC with age showed strong deviations from a simple linear form in the subcortical WM regions (p<0.001) (figure), a weaker deviation in the PLIC (p<0.001) and no significant deviation from a linear form in the genu and splenium. Likewise, the change of FA with age showed modest evidence of deviation in the subcortical WM regions, p=0.001 to p=0.1 and little evidence in the deep WM regions. The nonlinear least squares estimates of the time of regime change in the segmented models were about 3.2 months (confidence intervals of 2.2 to 4.0 months).

CONCLUSION
Good correlation was seen between FA increase and ADC decrease in all regions, with a stronger correlation seen in subcortical WM regions. Whereas FA and ADC changes in deep WM were best described by a linear form, the changes in subcortical WM were better modeled by a segmented line with a break point at approximately 3 months. These findings suggest subcortical WM may mature more rapidly across, approximately, the first 3 months in comparison to the remainder of the first year.

KEY WORDS: Infant, diffusion tensor imaging, apparent diffusion coefficient
Paper 185 Starting at 11:01 AM, Ending at 11:09 AM  
Changes in Global Rates of Cerebral Perfusion Associated with Normal Development as Measured with MR Arterial Spin Labeling

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PURPOSE
Numerous studies investigating age-associated variations in cerebral blood flow (CBF) in normal subjects describe higher rates of cerebral perfusion in early childhood that decrease to adult levels over time. Because of the relatively small sample size in many of these studies, precise timing of such evolving changes remains poorly defined. The purpose of the present investigation, therefore, was to evaluate CBF using arterial spin labeling (ASL) in a large population of normal children, adolescents, and young adults to better resolve the temporal course of age-associated changes.

MATERIALS & METHODS
Subjects between the ages of 5-30 years with no abnormalities on conventional MR sequences and no documented evidence of neurologic or psychiatric abnormalities on history/physical exam (n=112) were identified retrospectively from a pool of over 3000 MRI examinations with ASL perfusion imaging performed over 1 year. Whole-brain gray-matter (GM) perfusion (mL/100g/minute) was quantified in all subjects and plotted by age to define subgroups for further analysis. A 3 (age: 5-12, 12-19, 19-30) x 2 (gender: male, female) ANOVA was conducted using ASL measures of CBF in GM as the dependent measure. Bonferroni adjusted posthoc analyses subsequently were conducted to evaluate between-group effects.

RESULTS
Scatter-plots of CBF by age demonstrate a relatively sudden decrease in rates of CBF at age 12, after which there is little apparent difference between adolescents and adults. Subjects were parceled into 3 subgroups defined by years of age (5-12, 12-19, 19-30) to further evaluate this finding. For ASL measures of global CBF in GM, ANOVA revealed no interaction of age by gender [F(2,106)=0.75, p=.47]) or main-effect of gender [F(1,106)=2.42, p=0.12]. There was, however, a main-effect of age [F(2,106)=18.27, p<.001], such that rates of global CBF in GM declined with increasing age. More specifically, Bonferroni adjusted posthoc analyses of between-group differences revealed rates of CBF to be significantly lower in age subgroups 12-19 (75.9±25.3 [p<.001] and 19-30 (71.7±14.2) [p<.001], as compared to 5-12 (104.8±22.9). There was, however, no statistically significant difference in rates of CBF between age subgroups 12-19 and 19-30 [p=.75].

CONCLUSION
The present data are concordant with numerous prior studies that report decreases in rates of CBF between children and adults, using a variety of imaging methods. Although many of these investigations report gradual declines in CBF, present data demonstrate a more abrupt change that occurs at approximately 12 years of age. A similar rapid decrease in CBF at age 16 has been reported in a recent study that included 15 children and 8 adolescents (1). The sudden decrease in CBF at age 12 in the present investigation may be a function of the large sample size evaluated, allowing better resolution of age-associated changes. Such decreases in cerebral perfusion at age 12 are interesting, as declining CBF at this age may reflect underlying neurophysiologic processes heralding the onset of complex behavioral and cognitive changes that define adolescence.

REFERENCES

Paper 186 Starting at 11:09 AM, Ending at 11:17 AM  
Unilateral versus Bilateral Motor Representation as a Function of Age

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PURPOSE
With the increasing use of magnetoencephalography (MEG) in the pediatric and adult populations, our understanding of the functional organization of the brain can be advanced. Our purpose is to determine the change in laterality of motor activity.

MATERIALS & METHODS
Magnetoencephalography was recorded from 35 right-handed subjects with medically refractory epilepsy, but with no reported hemiparesis, using a 275-channel whole-head biomagnetometer. Active electrode coils were placed at fiducial points, and were digitized to allow for MEG-MRI coregistration. Motor mapping was performed with a self-paced (3-4 second) button-press using each index finger sequentially, to evaluate event related desynchronization (ERD) in the beta band (12-25Hz) in the interval 300 ms prior to and 200 ms after button-press. Third order gradiometer technology was used to reject strong distant sources (such as cardiac electrical activity). A linearly constrained minimum variance beamformer algorithm (SAM) detected localized activity. Areas of significant ERD are overlaid on MRI as statistical probability maps of activity. Quantification of the degree of precentral gyrus activity was performed using peak regional t-statistic describing extent of ERD. T-values were determined for contralateral and ipsilateral motor activity, and a laterality index (LI) was constructed [(contra - ipsi)/(contra + ipsi)].

RESULTS
In subjects under 30 years of age (n = 24), there was significant laterality, with a mean LI 0.43+/-.07. In subjects over 30 years of age (n = 11), activation tended to be bilateral, as represented by LI 0.13/+.08. This difference was statistically significant (p < 0.01). Overall, there was a significant negative correlation of LI with age (r = -0.44, p < 0.01).
The figure on the left is from functional motor testing of the right index finger in a 10.1-year-old female, showing the region of left motor ERD. The figure on the right is from functional motor testing of the right index finger in a 40.1-year-old female, showing bilateral regions of motor ERD.

**Conclusion**

In children and younger adults, motor representation is overwhelmingly unilateral. With aging, this becomes progressively more bilateral. An improved understanding of the expected functional representation over a range of ages allows for more accurate interpretation of experimental and clinical MEG data. These findings serve as a preliminary biological correlate of the maturation of interhemispheric corticocortical white matter connectivity, particularly via the corpus callosum.

**Key Words:** MEG, motor mapping, brain development

**Purpose**

To quantitatively assess the structural and functional correlates of hemiparesis in epilepsy patients with structural lesions, using quantitative tractography derived from diffusion tensor imaging and spectro-spatio-temporally restricted magnetoencephalography.

**Materials & Methods**

Eight epilepsy patients with moderate to severe hemiparesis underwent MEG and DTI examinations as part of their presurgical evaluation. As a comparison group, 36 patients, also with medically refractory epilepsy, but with no evidence of hemiparesis underwent similar examination. In addition to passive MEG recording of spontaneous discharges using a 275-channel biomagnetometer, MEG data also was collected during two periods of voluntary self-timed sequential index finger button-pressing. Evidence of motor activity was determined using a linearly constrained minimum variance beamformer (SAM) to allow voxel by voxel analysis of time-varying endogenous beta-rhythm activity (15-25Hz). Motor activity was inferred from those pixels showing statistically significantly reduced beta band power (event related desynchronization, ERD) in the latency range -300ms to +200ms relative to the button-press. Quantification of the degree of contralateral motor cortex activity was performed using the peak regional t-statistic describing the extent of ERD. DTI was performed using a 6-direction, b=1000s/mm² approach using 4 signal averages. Spatial resolution was 2mm x 2mm x 2mm. Post-processing was performed using the FACT algorithm implemented in the DTIStudio software package. Corticospinal tracts (CST) were defined using the 2 ROI approach with ROI’s placed in axial slices at the level of the brainstem and superiorly at the level of the posterior limb of the internal capsule, separately for each hemisphere. Quantification of the CST’s was performed using two metrics: the number of fiber paths (#fibers) and the total number of voxels involved in these fiber paths (#voxels). Comparison was made between hemiparetic and contralateral values of CST integrity as well as motor cortex functional activity using paired t-tests. Correlation between DTI and MEG measures was assessed across both hemispheres using a Spearman correlation coefficient. For DTI measures, CST laterality measures (defined as the relative hemispheric bias of DTI quantitative metrics) was compared against the non-hemiparetic group using unpaired t-tests.

**Results**

In patients with hemiparesis, the #fibers was significantly reduced in the contralateral (affected) hemisphere compared to ipsilateral (126+/−34 vs 270+/−39, p<0.01). Similarly #voxels was reduced in the contralateral hemisphere (511+/−102 vs. 943+/−63, p<0.05). The mean #fiber laterality index was 0.41+/−0.09, which was significantly greater than that of the control patients (0.11+/−0.02, p<0.01). 4/8 patients were unable to perform the motor task due to severe hemiparesis. 3/8 patients showed clear evidence of cortical reorganization based on MEG assessments of localization of motor function to the alternate hemisphere. Overall correlation between #fibers and peak t-test in motor cortex was moderate (r=0.47, p=0.1) in the hemiparetic patients in whom functional data could be obtained.

**Conclusion**

The structural (CST integrity) and functional (motor cortex ERD) correlates of patients’ hemiparesis could be quantitatively assessed using quantitative DTI and source localized, spectrally- and temporally-restricted MEG, respectively. White matter integrity appears significantly impaired in the affected hemisphere; furthermore functional evidence for cortical reorganization was observable in 50% of this sample.

**Key Words:** DTI, MEG, epilepsy
Paper 188 Starting at 11:25 AM, Ending at 11:33 AM
Radiation-Induced White Matter Injury: A Longitudinal Diffusion Tensor Imaging Study

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PURPOSE
The aim of this prospective longitudinal study was to evaluate if diffusion tensor imaging (DTI) can detect white matter pathology in children treated with radiation therapy (RT) for brain tumors and ALL.

MATERIALS & METHODS
Six patients (2 F, 8.7-18.7 years old) and 27 healthy children (14 F, 6.2-18.3 years old) were examined. All subjects had a baseline examination (before RT completion in patients), and 6- and 15-months follow-up examinations (after completion of RT in patients). Diffusion tensor imaging data were collected at 1.5 T using single-shot EPI (15 diffusion gradient directions, b=1000 s/mm², 24 axial slices, 5 mm slice thickness, 96x96 matrix, 240 mm FOV). DTI Studio and dsx softwares (1) were used for data processing. Apparent diffusion coefficient (ADC) and fractional anisotropy (FA) were measured by outlining 15 regions of interest (ROIs) in both hemispheres on color maps, and overlaying the ROIs on the FA and ADC maps. To estimate doses delivered to each ROI, FA maps were registered with treatment plan using CT simulation scan. Statistical analysis was performed using nonparametric Wilcoxon rank sum test and regression analysis.

RESULTS
At the baseline examination, patients had lower FA in 8 ROIs and higher ADC in 5 ROIs compared to controls (all p<0.05) (Figure). At the first follow-up examination, a tendency to normal FA and ADC values was detected in patients except for genu and splenium of corpus callosum where a decrease in FA was detected (p<0.05). At the second follow up (15 months postradiation) FA and ADC values continued to change in the direction to normal values in most ROIs. With increasing radiation dose, FA decreased and ADC increased in the genu of the corpus callosum (first follow up, p<0.05).

CONCLUSION
At the time of the baseline visit, abnormal FA and ADC values in white matter with normal appearance on conventional MRI in patients are likely due to the presence of malignancy, effects of chemotherapy, or surgery. The trend of FA and ADC normalization at the two follow-up visits may indicate white matter recovery from damaging effects of RT, which can be attributed to radiation-induced inflammation, demyelination, or vascular injury (2). Of the evaluated brain regions the largest effect of radiation dose on FA and ADC was detected in the genu of the corpus callosum, possibly suggestive of increased radiosensitivity of this brain structure.

REFERENCES

Paper 189 Starting at 11:33 AM, Ending at 11:41 AM
White Matter Abnormalities in High Functioning Autism Spectrum Disorder: A Combined Voxelwise and Tractography Analyses

Ashtari, M.¹ · Bregman, J.² · Nichols, S.² · McIlree, C.¹ · Spritzer, L.¹ · Adesman, A.¹ · Narain, M.¹ · Ardekani, B.¹

PURPOSE
Perform whole-brain voxelwise analysis and tractography using diffusion tensor imaging (DTI) in high-functioning youth with autism spectrum disorder (ASD) and demographically matched healthy controls (HC) to examine the neural basis for deficits in social-emotional reciprocity in ASD.

MATERIALS & METHODS
Thirteen ASD subjects (male; avg. age 11 years) and 12 age, gender, IQ, SES, and handedness-matched healthy controls underwent diffusion MRI. All subjects met ADI-R andADOS-G criteria for autistic or Asperger disorder. A 15-direction isotropic diffusion sequence was obtained covering the whole brain. Following rigorous registrations of the fractional anisotropy, radial diffusivity, axial diffusivity and trace maps, voxelwise ANCOVA (VANCOVA) analyses was performed. The entire cingulum bundles on the left and the right hemispheres and a portion of the left posterior cingulum tract radiating to the parietal lobe were extracted using DTI Studio. Correlation analyses were carried out between the results of voxelwise analyses and the diffusion parameters of all the extracted tracts and the social responsiveness scale (SRS) and the parent (ADI) and child (ADOS) diagnostic interview scores using the SPSS 11.0.

RESULTS
Compared to HC, ASD participants had increased FA values in the left posterior cingulate, pons, and the Rt. inferior frontal gyrus (p<0.002, cluster size ≥100 voxels). Increased axial diffusivity was found in the bilateral posterior cingulate, left pre -frontal, and the left cerebellum (p<0.002, cluster size ≥100 voxels). No significant changes in the radial and mean diffusivity parameters were found. Results of tractography showed no changes in the whole cingulum bundles but increased average FA was seen in the portion of the Lt. cingulum bundle radiating to the parietal lobe (p=0.05). Within group analysis of ASD subjects showed positive correlations between the Lt. posterior cingulate FA cluster value
CONCLUSION
Diffusion tensor imaging voxelwise analysis and tractography results showed increased FA in several key brain areas in youth with ASD compared with HC. Among ASD subjects, increased FA of the posterior cingulate gyrus (limbic circuit) was correlated positively with measures of social-emotional reciprocity and autistic mannerism. Our data suggest that alterations in the limbic system secondary to suboptimal connectivity may lead to core impairments of social interaction and behavior associated with the autism phenotype.

KEY WORDS: Autism spectrum disorder, diffusion tensor imaging, tractography

Paper 190 Starting at 11:41 AM, Ending at 11:49 AM
Fetal Nigrostriatal Connectivity Demonstrated by In Utero Tractography

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PURPOSE
The medial forebrain bundle (MFB) is an anatomically ill defined fiber pathway connecting the midbrain tegmentum with forebrain structures. Its functionally important dopaminergic input to the striatum and frontal cortex can be identified in vitro by 8 gestational weeks (GW) (1). The aim of this cross-sectional study was to identify the MFB using in utero diffusion tensor imaging (DTI) and tractography.

MATERIALS & METHODS
MR examinations of 40 nonsedated pregnant women (age at imaging: 28.2 GW; 18-37 GW) were performed using a 1.5 T scanner and a cardiac coil. Fetal neuroimaging included T2-weighted, T1-weighted and DT sequences (33 diffusion encoding directions, reconstructed voxel size: 1.44mm/1.45mm/4.5mm). Applying a streamline algorithm, a fractional anisotropy (FA) threshold of 0.15 and a maximum angle change of 27°, all trajectories passing through 2 regions of interest (midbrain tegmentum and the anterior limb of the internal capsule) were calculated. The mean FA and apparent diffusion coefficient (ADC) values as well as the length of the visualized trajectory were measured.

RESULTS
Beginning with 22 gestational weeks a trajectory passing through the midbrain tegmentum (substantia nigra), the anterior limb of the internal capsule and fanning out in ipsilateral frontal lobe was visualized unilaterally in 22.5% (9/40) (Figure 1, 26 GW). Three-dimensional morphology of the MFB was depicted bilaterally in 17.5% (7/40) (Figure 2, 23 GW). No significant linear correlation of MFB ADC (1.326±0.7µm2/ms - 1.707±0.7µm2/ms; mean 1.458±0.7µm2/ms), FA values (0.251-0.393) and fiber length (17.3cm-26.5cm) with gestational age was found.

CONCLUSION
Development of the fetal dopaminergic system can be studied no-invasively in utero by DTI. Nigrostriatal connectivity is represented by the MFB, which is visualized readily in vivo as a prominent trajectory as soon as 22 GW.

and the SRS subscale of social awareness (r=.6, p<0.03), and a trend in SRS autistic mannerism subscale (r=.50, p<.08). Extracted cingulate tract in this area also correlated positively with the ADI-R stereotyped and repetitive motor mannerism (r=0.54, p<.05).
REFERENCES

1. Verney C. Distribution of the catecholaminergic neurons in the central nervous system of human embryos and fetuses. 

Microsci Res Tech 1999;46:24-47

KEY WORDS: DTI, nigrostriatal connectivity, fetus

Paper 191 Starting at 11:49 AM, Ending at 11:57 AM

Abnormal Fetal Brain Development Investigated by In Utero Tractography

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PURPOSE
Diffusion tensor imaging (DTI) allows an in vivo assessment of microstructural tissue characteristics of the developing nervous system(1). This study aims to assess the potential of in utero DTI to visualize main projection and commissural trajectories in living unsedated fetuses with structural brain pathologies.

MATERIALS & METHODS
Fifteen unsedated fetuses (median gestational age: 23 gestational weeks - GW; 19-37 GW) with cerebellar abnormalities (n=6) and/or hydrocephalus (n=7), callosal dysgenesis (n=3), circumscribed parenchymal brain lesions (n=2), or other acquired or malformative (n=2) brain pathologies underwent in utero MRI on a 1.5 T system. The imaging protocol included T2-weighted, T1-weighted and echo-planar single-shot DT sequences (33 diffusion encoding directions, reconstructed voxel size: 1.44mm/1.45mm/4.5mm, acquisition time 1-2 minutes). Corticofugal (CF), thalamocortical (TC) and callosal (CAL) trajectories were defined by multiple regions of interest and calculated by a streamline algorithm. In 2 cases with in utero parenchymal lesions postnatal follow-up DTI examination was available.

RESULTS
In 2/15 cases artifacts corrupted the calculation of trajectories. In all other cases (13/15) at least one projection or commissural pathway could be visualized in utero. In cases with hydrocephalus the CF and TC trajectories were found passing densely packed through the posterior limb of the internal capsule and adjacent to the ventricles in the intermediate zone of the thinned cerebral wall (Figure 1a,b at 23 GW). Unilateral (2/3, aged 19 and 23 GW) or bilateral (1/3, aged 32 GW) CF and TC, with absent CAL connectivity was encountered in cases with callosal dysgenesis. The Bundles of Probst could be identified in 1 case (32 GW). Pre and postnatal imaging data were consistent in demonstrating missing ipsilateral TC and CF trajectories in prenatal parenchymal brain lesions (n=2).

CONCLUSION
Diffusion tensor imaging and tractography can be used in utero to visualize abnormal and normal patterns of cerebral connectivity. In utero tractography data are consistent with postnatal DTI results.

REFERENCES

KEY WORDS: DTI, in utero, fetus

Paper 192 Starting at 11:57 AM, Ending at 12:05 PM

Effects of Lithium Therapy on Brain NAA Concentrations in Adolescent Bipolar Depression

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PURPOSE
N-acetyl-aspartate (NAA) is recognized as a putative marker of neuronal integrity and/or metabolic function. A decrease in NAA concentration may suggest the loss of or decreased viability of neurons. Alternatively, decreased NAA concentrations may reflect impaired mitochondrial energy production as NAA is produced in the mitochondria, and NAA synthesis is reduced by mitochondrial respiratory chain inhibitors. Although the mechanism of action of lithium is largely unknown, it may possess neurotrophic effects by increasing bcl-2 expression and inhibiting protein glycogen synthase kinase-3β (1); these cellular actions, in turn, may be reflected in increased brain NAA concentrations (2). We conducted a spectroscopy study to examine the acute and chronic effect of lithium on brain NAA concentrations in depressed bipolar adolescents. In accordance with lithium’s purported neurotrophic effects, we hypothesized that prefrontal NAA concentrations would increase with lithium treatment.

MATERIALS & METHODS
Twenty-eight adolescents with bipolar I disorder in a depressive episode received open-label lithium 30 mg/kg, initially, and adjusted to achieve serum levels of 1.0-1.2 mEq/L. All subjects underwent a MRS scan at baseline, and on days 7 and 42 or termination from the study using a 1.5 T scanner. Spectra were acquired from the medial prefrontal cortex, and from the left and right lateral prefrontal cortices. Changes over time in NAA concentrations were examined within the
adolescents using likelihood-based mixed-model repeated measures analysis of variance. Post hoc paired t-tests with
corrections for multiple comparisons were performed. Subanalyses compared baseline and change in NAA concentra-
tions between remitters and nonremitters.

**RESULTS**
Medial prefrontal NAA concentrations decreased \((p=0.03)\),
with day 42 concentrations significantly lower than baseline
concentrations \((p=0.01, \Delta_8=0.7)\). No significant time effects
on NAA concentrations were observed in the left \((p=0.2)\) or
right lateral \((p=0.3)\) prefrontal cortices. No significant inter-
actions for time by remission status were observed with
regard to NAA concentrations in the medial \((F_{2,44}=0.2,\ p=0.8)\) and left lateral prefrontal \((F_{2,44}=0.3, \ p=0.7)\) cortices.
However, there was a significant interaction for time by
remission status regarding NAA concentrations in the right
lateral prefrontal cortex \((F_{2,44}=3.3, \ p=0.05)\). Change in
right lateral prefrontal cortex NAA concentrations from day
7 to day 42 significantly differed in remitters versus non-
remitters \((t=-2.4, \ p=0.02, \ d=0.7)\). Specifically, remitters
experienced a decreased mean in NAA concentrations \((t=7: \ 8.6 \ (SD=1.1); \ day \ 42: \ 8.2 \ (SD=1.1))\), while nonremitters
experienced increased mean NAA concentrations \((t=7: \ 8.2 \ (SD=1.1); \ day \ 42: \ 8.9 \ (SD=1.2))\). There were no differences
in baseline NAA concentrations in any of the voxels between
remitters and nonremitters.

**CONCLUSION**
Limited evidence from MRS studies in pediatric bipolar dis-
order indicates that lithium may not increase brain NAA con-
centrations, which suggests that the effects of lithium may
not be similar in younger aged patients to that in adults. In
contrast with prior studies of bipolar adults, this study
observes that prefrontal NAA concentrations do not signifi-
cantly increase from baseline following lithium treatment in
adolescent bipolar depression. Ongoing neurodevelopmental
processes, namely pruning, may confound the action of li-
thium.

**REFERENCES**

**KEY WORDS:** Bipolar disorder, spectroscopy, lithium

**Paper 193 Starting at 12:05 PM, Ending at 12:13 PM**

**Cine MR in the Evaluation of Pediatric Obstructive Sleep Apnea: Correlation of Image Findings with Management Outcome**

Herrod, H. C. · Hedlund, G. L.

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Salt Lake City, UT

**PURPOSE**
The objective of this study is to present our institution’s
recent and ongoing progress in evaluating pediatric obstructive
sleep apnea utilizing cine MR imaging and deep seda-
tion. Goals in imaging were to elicit airway obstruction and
to safely and effectively identify the level of obstruction for
presurgical planning.
Material and Methods

High-resolution T2-weighted anatomical images of the posterior fossa and cervical spine were acquired with a volumetric VIPR sequence in normal subjects. With a commercial software for semiautomatic segmentation (MIMICS), a three-dimensional (3D) model of the subarachnoid space for this image volume was created. The model volume then was converted into a set of surfaces using another program, Geomagic. Finally, to enable the use of computational fluid analysis, the surfaces were converted to a “mesh”, that is a series of connected points that defines the inner and outer surfaces of the space. With a boundary element method (BEM) and with flow rates typical of diastolic and systolic CSF flow, velocity and pressure were calculated for the subarachnoid space defined in the model. Velocities were compared with those measured by means of a standard PC MR axial image sequence in selected locations. Velocity and flow were calculated for the same model with CSF flow doubled and for CSF flow obstructed posterior to the spinal cord at the foramen magnum.

Results

In the model of the normal subarachnoid space, CFD analysis showed peak systolic velocities in the midline in the pontine cistern. At the level of the foramen magnum and lower in the spinal canal the flow diverged from the midline, with peak velocities found anterolateral to the spinal cord. In the modeled case CFD analysis showed peak diastolic velocities in similar location and in similar magnitude to systolic velocities. These patterns of peak velocities correspond accurately to those measured with PC MR in normal subjects. Obstructing flow in the posterior foramen magnum in the model increased the velocity of CSF flow anterior to the brain stem and cord. Patterns of CSF flow, including flow jets and synchronous bidirectional flow seen in the Chiari I malformation were observed in the model for some flow rates and obstruction posterior to the cord.
demonstrated in the first patient described above. A follow-up MRI and \(^1\)H MRS were performed 3 months after the accident demonstrated severe atrophy of the cerebral parenchyma. The \(^1\)H MRS findings progressed with acutenation of decrease of 54% in the NAA/Cr ratio and an increase of 75% in the Myo/Cr ratio, and persistence of the Lip-Lac peak. There was a decrease in the Cho/Cr ratio to normal values and visual inspection demonstrated a decrease of Glx level.

**SUMMARY**

\(^1\)H MRS findings in near drowning hypoxic encephalopathy can demonstrate precocious biochemical alterations not seen on MRI and that can precede brain changes on MRI. The presence of a Lip-Lac peak and elevation in the Glx levels are predictors of poor prognosis along with irreversibility of metabolite ratios. Reversibility of metabolite ratios on follow-up examination correlates with a good outcome.

**REFERENCES**


**KEY WORDS**: Near drowning, hypoxic, proton MR spectroscopy

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**Tuesday Afternoon**

12:15 PM - 1:30 PM

La Louisiane Ballroom

(22) ASPNR Programming: Pediatric Epilepsy

**Self-Assessment Module (SAM)**

*Audience Response Plus System (ARS+)*

(197) Clinical Presentation of Childhood Epilepsy

— Angus A. Wilfong, MD

(198) Pathology of Epilepsy and Epileptic Disorders

— Meenakshi B. Bhattacharjee, MD

(199) Neuroimaging of Pediatric Epilepsy

— Elysa Widjaja, MD

Moderator: Jill V. Hunter, MD

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

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

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**Clinical Presentation of Childhood Epilepsy**

*Angus A. Wilfong, MD*

Dr. Wilfong is an Associate Professor of Pediatrics and Neurology at Baylor College of Medicine and is Medical Director of the Comprehensive Epilepsy Program at Texas Children’s Hospital, Houston, Texas. Dr. Wilfong earned his BSc in physiology and his MD at the University of Saskatchewan in Saskatoon, Saskatchewan, Canada. After graduating, he completed his internship and in pediatrics at the Royal University Hospital and then did his residency in pediatric neurology at Baylor College of Medicine in Houston, TX. Subsequent fellowships in clinical neurophysiology and epilepsy also were conducted at Baylor College of Medicine. Dr. Wilfong’s research interests are primarily devoted to medical and surgical pediatric epilepsy. He
Pathology of Epilepsy and Epileptic Disorders

Meenakshi B. Bhattacharjee, MD

PRESENTATION SUMMARY
There have been spectacular advances in the field of epilepsy in the past few decades, and especially in the understanding of the pathologic basis and consequences of epilepsy. Magnetic resonance imaging (MRI) has uncovered the underlying basis of many cases previously considered "cryptogenic," and occult cortical dysplasia, hippocampal sclerosis, and small neoplastic/hamartomatous lesions are now increasingly revealed in patients with chronic, apparently cryptogenic epilepsy. This has led to a re-examination of the clinical importance of the pathologic substrates, has given the option of surgical treatment in some cases, and led to a better understanding of the prognosis. Progress in neurochemistry and neurophysiology of epilepsy, and the brain changes, both causal and resulting from epilepsy, are now far better understood. Modern descriptions of the neuropathologic basis of epilepsy take into account the data from recent research in allied fields. A clinically oriented framework to describe the pathology makes it relevant to clinical and radiologic practice. The pathologies of temporal lobe epilepsy and the more recently delineated categories of cortical dysgenesis/dysplasia, and clinicopathologic aspects of sudden death in epilepsy will be addressed. Epilepsy in childhood poses very different problems compared with the adult condition, and pediatric epilepsy pathology is separately described taking into consideration the important influence of age. The developing human brain appears to be particularly vulnerable to epilepsy, and the morphologic features of secondary or symptomatic epilepsies will be described. However, it is important to remember that over two thirds of childhood epilepsies are considered to be idiopathic or primary, and most are genetic in origin. The absence of histopathologic changes does not exclude a functional abnormality, and the channelopathies are emerging rapidly as an important basis for idiopathic epilepsy. The pathologic processes which are the basis of epilepsy in children include malformations, inherited metabolic disorders, neoplasia/phyakomatoses, hypoxia-ischemia, infection, and unknown categories; this talk will address the major categories, with descriptions of selected, particularly illustrative pathologic entities.

Neuroimaging of Pediatric Epilepsy

Elysa Widjaja, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Recognize the epileptogenic substrates responsible for intractable epilepsy in pediatric population.
2) Review MRI techniques for pediatric epilepsy imaging.
3) Review the utility of magnetoencephalography and nuclear medicine imaging in pediatric epilepsy imaging.
Intractable epilepsy can have a significant impact in the development of a child. In approximately 30% of intractable epilepsy, medical treatment alone may not be sufficient to control the seizures. In those with refractory epilepsy, surgery should be considered. Presurgical workup of medically refractory epilepsy includes: 1) MR imaging to identify a structural abnormality, 2) magnetoencephalography (MEG) or nuclear medicine study including PET or ictal/interictal SPECT to identify the epileptogenic zone, 3) video EEG to characterize the seizure semiology and 4) neuropsychological evaluation. In children with intractable epilepsy, the epileptogenic lesions differ from those of adults with intractable epilepsy. Cortical malformations and developmental tumors are more commonly encountered in the pediatric population. In contrast, hippocampal sclerosis is the predominant epileptogenic lesion in the adult population. MR imaging is the main investigating tool for evaluating the epileptogenic lesion. In children with intractable epilepsy, MR detects a lesion in up to 80% of cases. Optimal MR protocol for epilepsy imaging should include T1, T2, proton density and FLAIR in at least two orthogonal planes covering the whole brain. Three-dimensional T1-weighted volume sequence with slice thickness of 1.5mm or less should be included and the data can be reformatted into several orthogonal planes or used for quantitative assessment or curvilinear reformat. The interpretation of MR images should be done in the context of clinical knowledge of the seizure semiology and EEG findings. In addition to identifying the epileptogenic substrate, it also is crucial to localize the eloquent cortex and this can be achieved with functional MR or MEG. The associated eloquent white matter tracts including corticospinal tracts and optic radiations can be assessed using diffusion tensor imaging. Magnetoencephalography measures magnetic field distributions and has the capability to localize brain activity with superior spatial and temporal resolution. The localized magnetic fields can be superimposed on anatomic brain imaging, referred to as magnetic source imaging (MSI). Magnetoencephalography localizations of ictal spike of epileptogenic zone have been found to be similar to invasive intracranial EEG. The yield from MEG is considered to be higher in patients with neocortical epilepsy than in those with mesial temporal lobe epilepsy. A potential limitation of MEG is the ability to localize spike sources deep within the brain parenchyma. Intertical PET or combined ictal/interictal SPECT identify the epileptogenic zone as an area of abnormal metabolism. The area of hypometabolism on interictal PET covers a larger area compared to the epileptogenic zone identified using invasive intracranial monitoring. Intertical focal neocortical hypermetabolism on PET may occur in early childhood epilepsies. The ictal SPECT examination will identify focal hyperperfusion whilst the interictal SPECT examination will identify focal hypoperfusion in the region of the epileptogenic zone. A potential limitation of ictal/interictal SPECT is that the spatial resolution of these studies is inferior to that of PET. Data on MEG spike sources or abnormal metabolism identified on nuclear medicine studies, MR imaging identified epileptogenic substrate as well as video EEG information are used in combination for guiding invasive intracranial monitoring.

**Tuesday Afternoon**

1:30 PM - 3:00 PM
Room 206/207

(23) (ASFNR) State of the Art in Brain Tumor Presurgical Mapping I: Clinical Bold fMRI

(200) fMRI for Presurgical Mapping: Introduction and the Neuroradiologist’s Perspective
— Jay J. Pillai, MD

(201) Functional Mapping: The Neurosurgeon’s Perspective
— Cameron W. Brennan, MD

(202) fMRI for Language Mapping
— Andrei I. Holodny, MD

(203) fMRI for Sensorimotor Mapping
— John L. Ulmer, MD

Moderator: Jay J. Pillai, MD

**fMRI for Presurgical Mapping: Introduction and the Neuroradiologist’s Perspective**

*Jay J. Pillai, MD*

**LEARNING OBJECTIVES**

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

1) Recognize the role of the neuroradiologist in presurgical functional mapping.
2) Illustrate the use of functional MR imaging in preoperative risk assessment.
3) Review the impact presurgical mapping can make on surgical management of brain tumors.

**PRESENTATION SUMMARY**

The role of the neuroradiologist in current presurgical mapping of brain tumors and preoperative risk assessment will be discussed both in terms of clinical impact on surgical planning and in terms of evolution of fMRI and DTI from purely scientific tools to clinically viable imaging modalities.
**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Discuss the indications for language mapping by fMRI.
2) Review the neuroanatomy of human language including variants.
3) Summarize the paradigms used in fMRI of language.
4) Cite the caveats and pitfalls of clinical fMRI interpretation.

**PRESENTATION SUMMARY**
Functional MRI (fMRI) is becoming more commonly used in the preoperative assessment of brain tumor patients. The main clinical indications for preoperative language mapping by fMRI include helping the neurosurgeon decide whether or not to attempt the resection, preoperative counseling of the patient, deciding whether or not to map the patient during the operation by direct cortical stimulation and actually guiding the resection itself. The functional anatomy of the main language areas consist of Broca's area and Wernicke's area as well as a number of secondary (but important) language centers. There are a number of normal variants of language organization. Organization of the language centers also can be affected by various pathologies including the presence of tumors themselves. These pathologies have been shown to cause cortical reorganization or brain plasticity. We will present the different language paradigms used to optimize identification of various language centers and describe the positive and negative points of each. In interpreting clinical fMRI images, it is important to keep in mind the physics and physiology of both the BOLD sequence as well as of the tumor itself since factors can affect the fMRI signal. By understanding these factors, one can improve the accuracy of fMRI interpretation.

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**Functional MR Imaging for Sensorimotor Mapping**

*John L. Ulmer, MD*

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Review basic sensori-motor system anatomy, as relates to presurgical fMRI mapping.
2) Develop an awareness of differential reorganization properties in the motor system, as it relates to surgical care.
3) Identify basic mapping strategies using fMRI.
4) Appreciate the complimentary nature of fMRI and DTI.
Tuesday Afternoon

1:30 PM - 3:00 PM
Room 201/202

(25) ASNR Business Center
Programming: Part I

(205) Practicing Medicine (not Business): Easing the Constraints on Physicians
— Andrew F. Simon, PhD, PsyD

(206) Pay for Performance and Radiology
— David J. Seidenwurm, MD

Practicing Medicine (not Business): Easing the Constraints on Physicians

Andrew F. Simon, PhD, PsyD

Presentation Summary
The practice of radiology has broadened such that physicians now are being asked to take on numerous roles. In addition to providing medical care, radiologists are expected to keep a close watch on business and economic factors affecting their practices. The premise of this lecture is that the practice of radiology can be enhanced through a greater understanding of organizational structure. In turn, this knowledge will strengthen the functioning of a medical practice, allowing radiologists more time to address the medical issues requiring their expertise. Organizational structure will be examined through the lenses of systems theory and the theory of embedded intergroup relations. Both perspectives have direct impact on understanding the way organizations function. An application of these views to a radiologic practice will be applied. The intent of this presentation will be to provide radiologists with the insight needed to manage the internal dynamics of their practices, as well as that needed to manage demands that are placed on them externally (e.g., insurance companies). Small changes to current organizational structures can have significant impact when done with the proper awareness of how businesses function within a larger system.

Pay for Performance and Radiology

David J. Seidenwurm, MD

David Seidenwurm was raised in New York City, and attended Stanford University and the Harvard Medical School. He completed his residency at Stanford, fellowship at NYU and was an assistant professor at UCSF in neuroradiology before moving to private practice. He has been with Radiological Associates of Sacramento for 17 years and currently serves as Chairman of the Diagnostic Division. He has represented Neuroradiology in various positions related to utilization and appropriateness, performance measure development and metrics. He has been Associate Editor of Radiology and a member of the editorial board of Diagnostic Imaging. His writing has appeared in medical and popular publications from AJNR and Radiology to JAMA, and form National Review to the New Yorker. He is married and has two teenaged daughters.

Presentation Summary
Pay for performance in medicine is based on the principle, widely applied throughout our society, that people will perform better if paid to do so. While many philosophical and practical objections may exist, the trend is in the direction of more performance based reimbursement systems. The remaining questions seem to be how and to what extent, rather than whether or when. Designing relevant performance measures is challenging. Potentially useful measures must address documented gaps in care, deviations of practice from guidelines and standards based upon high quality data. Measures must be easy to understand and implement, success must be feasible and the measured variable must be under the physicians control. In addition the burden of implementation must not fall on patients through adverse selection, nor to physician through undue costs. In practice, successful performance measure development involves a collaborative process in which multiple stakeholders of differing perspectives are represented. The evidence for improvement of health care through pay for performance is comparable to the evidence that supports much of what neuroradiologist do daily.
Perfusion Imaging

Pina C. Sanelli, MD

The Postoperative Back

Jeffrey S. Ross, MD

**LEARNING OBJECTIVES**

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

1) Define the common causes for failure back surgery.
2) Identify imaging features of common postoperative pathology.
3) Define the role of CT/myelography and MR imaging for postoperative state.

**PRESENTATION SUMMARY**

The greatest costs connected with low back pain occur in patients who have pain longer than 3 months and those with recurrent disabling pain episodes. Upwards of 5 million people are disabled by back pain, with recurrences of pain occurring in from 60-85%. Low back pain is the most expensive health care cost in patients between 20 and 50 years old. Rehabilitation in this troublesome group of patients must focus on psychosocial factors as well as biologic factors such as aerobic conditioning and muscle function. The imaging evaluation in this group plays a critical role, giving causes for continued pain and functional incapacitation in 20% of cases. Causes of failure of spine surgery may be divided into: hematoma, infection, unrecognized free fragment.

Delayed recurrence of low back pain and/or sciatic pain to be covered include: arachnoiditis, epidural fibrosis, facet degenerative change, instability, new herniation, spinal stenosis and disk space infection.
Detection of BOLD Response to Single Stimuli in Single Functional Units of Human Visual Cortex Demonstrated at 3.0 T

Atkinson, I. C. · Nemani, A. · Flannery, M. P. · Thulborn, K. R.
University of Illinois at Chicago

PURPOSE
To demonstrate the detection of BOLD responses to individual visual stimuli in single functional units of human visual cortex at 3.0 T. Responses are shown to be probabilistic rather than deterministic at the scale of ocular dominance columns.

MATERIALS & METHODS
Functional MRI using blood oxygenation level dependent (BOLD) contrast was performed at 3.0 T (GE Signa, HDx, WI) over the visual cortex of healthy volunteers using a 4.5-inch surface coil. High-resolution (voxel=0.6x0.6mm², 3mm thickness) gradient-echo, echo-planar imaging was performed with dense temporal sampling (TR=500 ms) through the primary visual cortex along the inferior bank of the calcarine fissure. The paradigm consisted of 25 trials, each of 25 seconds duration of central fixation, starting with 2 seconds of alternating (10Hz) black and white checkerboards in the right peripheral visual hemifield followed by every 23 seconds without stimulus. The subject completed the experiment three times (both eyes open, left eye only and right eye only). Data were accepted only for head motion of less than 0.5 mm. Single events were performed using a voxel-wise gamma variate hemodynamic response model for each event across each voxel time-course. The percent consistency of activation across 25 trials for each voxel then was computed with a contrast-to-noise ratio (CNR) greater than 0.1. This consistency then was compared to the predicted false positive rate and false negative rate calculated for the same 0.1 CNR threshold and the noise characteristics of the time-courses.

RESULTS
Sufficient CNR is available for single event detection at an in-plane resolution of 0.6 mm². Even with a conservative CNR threshold of 0.1, which heavily favors false positives over false negatives, highly inconsistent responses were found for most voxels. Figure 1 shows three representative time-courses and the fitted responses. The detected consistency was well below the expected false negative rate. Nonactive voxels from the contralateral side showed a detected consistency matching the expected false positive rate. This result was reproducible across all datasets.

CONCLUSION
Traditional processing of fMRI data using signal averaging and spatial blurring assumes that the response to a stimulus is deterministic and therefore reproducible but fails to describe high-resolution fMRI data of the human brain when single-event detection can be performed. This implies that repeated stimuli may not be processed by the identical functional columns but rather selected from a pool of available columns.

KEY WORDS: High-resolution fMRI, event-related fMRI, single event
MATERIALS & METHODS
We explored with fMRI at 3 T ten right-handed volunteers (6 female, 4 male, aged 20 to 31 years old). Functional MRI sequential paradigm included two tasks, each separated by resting phases. The simple calculation (CS) task consisted in resolving visually presented elementary operations (e.g., 2x3, 10-5…). Calculation with elaborated strategy (CX) corresponded to personal combination of operations on a set of six numbers, to reach a proposed three-digit number. Functional data were realigned onto an anatomical model, then statistical group analysis was performed using FSL 4.0 (Oxford University) (General Linear Model, corrected threshold, p<0.05).

RESULTS
Cortical areas responding preferentially to CS task were bilateral striatum, cingular gyrus, supplementary motor area (SMA), posterior temporal, precentral areas, and left posterior cerebellar hemisphere. Relevant areas for CX task were located in bilateral parietal lobes (superior parietal gyrus, horizontal intra parietal sulcus, medial parietal gyrus), ventromedial and dorso lateral areas of prefrontal gyrus, and right posterior cerebellar hemisphere.

CONCLUSION
In our experiment, bilateral cortical activation with left hemisphere predominance was observed with CS as well as CX. The pattern of the cortical activations in CS suggests simple fact recall from long-term memory as demonstrated by others. In CX, predominant response in parietal areas may correspond to elaborated strategy of calculation, associated to evaluation, manipulation and storage of intermediary results in prefrontal areas. Comparison of CX to CS confirmed the intervention of frontal associative areas, parietal and caudate nucleus for elaborated calculation strategy. These preliminary results suggest two different calculation processes between simple operations and calculation with strategy, associated either with long-term memory or with temporary working memory.

KEY WORDS: fMRI, mental imaging, calculation

Paper 213 Starting at 3:46 PM, Ending at 3:54 PM
Comparison of Three Methods of Seeding to Demonstrate the Hand Area White Matter Fibers with Diffusion Tensor Tractography

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PURPOSE
Diffusion tensor imaging (DTI) tractography is a potentially useful tool in image-guided neurosurgical planning, as it may assist the surgeon to avoid damaging the critical neural fibers. Hand motor fibers are of particular importance because their damage can affect fine motor tasks. The seeding region for obtaining corticospinal tract is typically in the cerebral peduncles of the brainstem. Seeding in the peduncle reliably identifies fibers to the leg region; however, fibers associated with the putative hand area are rarely found using this method of tractography. In this study we compared seeding in the cerebral peduncle with two other methods of seeding to demonstrate the hand fibers.

MATERIALS & METHODS
Tractography was performed in four healthy subjects, and one patient with a cavernous hemangioma, using in-house, publicly available software, 3D-Slicer (http://www.slicer.org). Three different seeding methods were applied to the left and right hand motor fibers. Method 1: The cerebral peduncles were segmented at the level of the midbrain. The whole peduncle and the middle one third were investigated separately as seeding regions of interest (ROI). Method 2: Functional magnetic resonance imaging (fMRI) using echo-planar imaging was obtained while the subjects performed a hand clenching task (right and left hand separately). The functional images were processed using SPM2 (Statistical Parametric Mapping) to create activation regions. Each activation region was dilated to include the corresponding subcortical white matter and used as the seeding ROI for tractography. Method 3: Tractography was performed everywhere in the white matter using a 2 mm seedpoint grid. Two ROIs were chosen, including the cerebral peduncle and the dilated hand-related cortical activation area. Fibers which passed through both ROIs were selected from the whole brain tractography.

RESULTS
Method 1: Tractography for all cases clearly depicted the corticospinal tract, but the fiber tracts terminated in the foot/leg region only, based on the fMRI maps showing cortical activation areas, and also the motor homunculus. None of the cases showed fibers with a cortical destination consistent with hand motor fibers. The result was similar regardless of whether the seeding ROI was based on the whole peduncle or the middle one third. Method 2: In eight of 10 hemispheres, we could obtain only small curved fibers near the cortex. Long fibers, consistent with hand motor fibers, were observed in two subjects, both for the left hand. Method 3: In six of 10 investigations, hand motor fibers were observed, bilaterally for two subjects, and on the right side only for two other subjects.

CONCLUSION
Using whole brain tractography and selecting the appropriate hand fibers that pass through both ROIs (the cerebral peduncle, and the hand-related cortical activation area) can better delineate putative hand fibers than using either the cerebral peduncle or the fMRI-based ROI alone. However, hand motor fibers are not always demonstrated even with this approach. We hypothesize that crossing fibers in this region interfere with the standard tractography approach.

Acknowledgment: This study was supported by NIH-NCRR U41RR019703-01A2.

KEY WORDS: Diffusion MR imaging, corticospinal tract
Paper 214 Starting at 3:54 PM, Ending at 4:02 PM

Topographical Organization of Human Corpus Callosum as Revealed by Diffusion Tensor Imaging and Functional MR Imaging

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1Università Politecnica delle Marche, Ancona, ITALY, 2Azienda Universitaria-Ospedaliera Umberto I, Ancona, ITALY

PURPOSE

The present study aimed at outlining, with diffusion tensor imaging (DTI), the topographical organization of human corpus callosum (CC) in healthy subjects and patients with callosal resection. The possibility of describing a topographical organization by means of functional magnetic resonance imaging (fMRI) also was verified.

MATERIALS & METHODS

Twelve healthy volunteers and seven callosotomized patients gave their informed consent to participate in the study. The protocol was approved by the Ethical Committee of Università Politecnica delle Marche Medical School (Ancona, Italy). Patients had varying extent callosal resection to treat severe epilepsy: four had total callosotomy, two partial anterior and one partial posterior resection. The study was carried out with a GE Signa 1.5 T magnet. Analyzing the direction of the water maximum diffusivity, DTI enabled the virtual reconstruction of fibers crossing the CC diffusion tensor tractography (DTT). Functional data also were collected in the same subjects during studies of the cortical representation of tactile, gustatory and visual sensitivity. All stimuli were presented according to a block-design protocol that alternated periods of rest and stimulation. Regions of interest (ROI) were selected in primary gustatory (GI), somatosensory (SI) and visual (VI) cortical areas activated during fMRI studies.

RESULTS

Callosal fibers interconnecting areas GI of the two hemispheres crossed the anterior part of CC, as evident in control subjects and in the patient with partial posterior resection. Fibers interconnecting areas SI of the two hemispheres crossed the posterior callosal body, as shown in control subjects and in the two patients with partial anterior resection. Callosal fibers interconnecting areas VI of the two hemispheres crossed the splenium of CC, as evident in control subjects and in the two patients with anterior partial resection. In fMRI studies, activation foci were detected in CC. Foci evoked by taste stimuli were detected in most subjects in the anterior part of CC (i.e., the genu, in the same region where DTT evidenced crossing fibers from areas GI); those elicited by tactile stimulation of different body regions lay in the posterior part of the body of CC, in the same region where DTT evidenced crossing fibers from areas GI. These foci displayed two characteristics: 1) stimulation of various body regions often elicited activation of different CC areas, with foci evoked by foot, leg, trunk, arm, hand and face stimulation being arranged posterior to anterior along CC; 2) in some subjects, activation evoked by hand stimulation was split into multiple foci, with the principal focus lying in the posterior callosal body. Activation foci evoked by visual stimulation were seen in the splenium of CC, in the same region where DTT evidenced crossing fibers from areas VI.

CONCLUSION

Present DTT results indicate that CC displays a topographical organization, whose general features are in line with data from previous human lesion studies and monkey neuroanatomical reports. Moreover, fMRI findings show that local increase of blood flow evoked by neural activity is detectable also in a white matter structure, likely mediated by astrocytes.

KEY WORDS: Brain imaging

Paper 215 Starting at 4:02 PM, Ending at 4:10 PM

Evaluation of the BOLD Response in the Administration of Ibuprofen-Arginine versus Placebo in an Experimental Model for Acute Pain

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PURPOSE

This was a pilot study to evaluate the modifications induced in the central nervous system by the administration of ibuprofen-arginine in an experimental model for acute pain.

MATERIALS & METHODS

Ten healthy volunteers (right-handed males; age range: 22-34 years, 27.3 years old) were enrolled, after giving their informed written consent, in this preliminary double-blind random cross-over study. BOLD fMRI acquisitions during electrical-pain stimulation of the median nerve of the right wrist were performed prior and 30 minutes after the administration of either ibuprofen-arginine or placebo. This procedure was repeated 7 days later with the opposite test condition. A 1.5 T magnet and a standard coil were used to acquire gradient-echo EPI T2*-dependent and 3D MPRAGE T1-dependent morphologic sequences. Brain Voyager 4.6 was used to elaborate the functional data, which were analyzed using regression statistical files (General Linear Model, GLM). We measured the pre- versus post-BOLD signal variation in seven different ROIs, anatomically defined as cSI, cSIIp, cSIIa, iSIIp, iSIIa, cIM, and iIM. Wilcoxon test and t-test (for confirmation) were applied to analyze nonparametric and parametric data, respectively.

RESULTS

We observed a trend of increased BOLD signal after ibuprofen (p<2%, except the Insula Media) which were significantly greater then those seen in the placebo group for cSIIa and iSIIa (p<3%). Univariate analysis of the means justify the exclusion of confounding factors (period and carry-over effect were not significant) confirmed the major contribution of the BOLD response to ibuprofen in cSIIa and iSIIa, (P value = 0.071; ibuprofen versus placebo).
The results support the conclusion that ibuprofen-arginine increases the BOLD response in the activated areas interfering with local cerebral autoregulation (a pure vascular mechanism).

**Key Words:** Ibuprofen-arginine, BOLD fMRI, acute pain

**Purpose**
Fibromyalgia (FM) is a chronic pain condition that afflicts 2-4% of the population in industrialized countries. Data from different neuroimaging methods consistently identify activation of the primary and secondary somatosensory cortices, the insula, the anterior cingulate, the thalamus, the dorsal lateral prefrontal cortex, and the basal ganglia in response to painful stimulation in FM patients. The purpose of this study was to assess for changes in water indices as defined by diffusion tensor imaging (DTI) in a few of these regions implicated in pain processing between FM patients and healthy controls (HC); correlations between apparent diffusion coefficient (ADC) and fractional anisotropy (FA) values and clinical symptoms also were investigated.

**Materials & Methods**
The material consists of 17 FM patients (15 female, 2 male, mean (sd) age=40.7 years (8.3)) and 22 pain-free healthy controls (HC) (19 female, 3 male, mean (sd) age=43.1 years (11.5)). Both FM and HC subjects underwent a 1-day study obtaining the clinical history, pressure testing and completion of self-report questionnaires followed by a standard pre and postcontrast-enhanced MRI (1.5 T scanner (GE Medical Systems) for evaluation of structural abnormalities. The subjects were evaluated for clinical pain with a 10cm Visual Analog Scale (VAS) and experimental pain with pressure pain threshold by applying pressure stimuli to the subject’s left thumbnail using a stimulation device which eliminates any direct examiner/subject interaction. Diffusion tensor imaging (DTI) was obtained using a single-shot spin-echo EPI technique. Apparent diffusion coefficient and FA maps were calculated on an off-line workstation. Mean ADC and FA in the different regions were compared between the two groups and correlated to clinical and experimental pain data.

**Results**
No differences were seen in mean scores for ADC or FA in any region between FM and HC. Both ADC and FA demonstrated significant more variability in left posterior insula (p=0.02). The FA in posterior insula was significantly negatively correlated with the sensory dimension of clinical pain (SFMPQ sensory score: r=-0.67, p<0.01). In HC the ADC and FA values were negatively correlated (r=-0.50, p=0.02) in the posterior insula but such a correlation was not present in the FM (r=0.17, p=0.5).

**Conclusion**
Our study provides evidence from yet another functional imaging modality that there are subtle abnormalities in neuronal function in pain processing regions of the brain in fibromyalgia. In particular, these data support previous data indicating that posterior insula play a significant role in the pain processing in FM as suggested previously by other neuroimaging methods such as MR spectroscopy.

**Key Words:** Fibromyalgia, apparent diffusion coefficient, fractional anisotropy

**Tractography of the Ansa Lenticularis in Parkinson’s Disease**
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**Purpose**
The ansa lenticularis (AL) and the lenticular fasciculus (LF) provide pathways of communication between the globus pallidus and the thalamus. These pathways have been implicated as potentially related to the development of Parkinson’s disease and its treatment (1, 2). However, these fibers are small and have not been extracted by using diffusion-tensor imaging (DTI). The purpose of this study was to evaluate the ability of 3T DTI MRI to detect the AL and LF.

**Materials & Methods**
Axial DTIs were acquired by using a 3T MR scanner in eleven patients with Parkinson’s disease and eight age- and sex-matched normal subjects. The patients all have advanced but not end-stage Parkinson’s disease. Diffusion tensor images were reviewed on a workstation (ADW 4.0; GE Medical Systems) and processed with FuncTool software. The globus pallidus and thalamus were used as seed and target ROIs for extracting fiber tracts, respectively.

**Results**
The virtual dissection with the creation of tractograms clearly demonstrated the AL and portions of the thalamic peduncle in 10 of 11 patients and seven of eight normal subjects. No LF was depicted. Qualitatively, pathways of ALs in the patients had a very similar distribution to those in the normal subjects.
CONCLUSION
With high reproducibility DTI at 3 T appears to be a promising technique for the virtual dissection of the AL. This provides a potentially powerful tool going forward for the evaluation of Parkinson’s disease. Also, the delineation of the AL may provide critical information related to the surgical treatment of Parkinson’s disease given prior methodologies that have found the surgical disruption of this system to be beneficial. The imaging of the AL with patients being treated medically also may be of great potential value.

REFERENCES

KEY WORDS: Diffusion-tensor imaging, Parkinson’s disease, ansa lenticularis

Paper 218 Starting at 4:26 PM, Ending at 4:34 PM
Functional MR Imaging and Tractography at 3 T: Combined Intraoperative Integration for Brain Tumor Resection
Leach, J. L.1,2,3 · McPherson, C.1,2,3 · Tackla, R.3 · Warnick, R.1,2,3 · Narayan, R.1,2,3 · Theodosopoulos, P.1,2,3 · Zuccarello, M.1,2,3 · Tew, J.1,2,3
1 Cincinnati Children’s Hospital Medical Center, Cincinnati, OH, 2 University of Cincinnati College of Medicine, Cincinnati, OH, 3 The Neuroscience Institute, Cincinnati, OH, Mayfield Clinic, Cincinnati, OH

PURPOSE
Functional MRI (fMRI) and diffusion tensor tractography are newer imaging techniques that have significant potential for assisting in surgical planning and performance in patients with brain neoplasia. There have been few studies demonstrating the utility of combining tractography and fMRI data for intraoperative use with neuronavigation, particularly using the advantages of higher field strengths. We present our experience using combined fMRI, tractography, and high-resolution anatomical MRI imaging at 3 T for neurosurgical planning and neuronavigation in a consecutive series of brain tumor patients.

MATERIALS & METHODS
Sixteen consecutive patients with brain neoplasms involving or near eloquent cortical regions underwent comprehensive fMRI, tractography, and high-resolution anatomical imaging protocol for purposes of surgical planning and neuronavigation. All examinations were performed at 3 T (GE HD and HDx systems). Functional MRI paradigms included: visually and auditorily presented noun-silent verb generation, visually presented letter-word completion, story listening contrasted with nonsense or backwards speech, finger tapping, foot movement, tongue movement, and visual stimulation. Tractography utilized 25 direction DTI with seed and endpoints defined by areas of fMRI activation and anatomical landmarks. The arcuate fasciculus, corticospinal tract, and geniculocalcarine tract were outlined depending upon lesion location. Three to 5 mm slice thickness and 128 x 128 matrix were used for both. High-resolution isotropic FSPGR T1-weighted images without and with contrast and thin section (2 mm) FSE T2 and FLAIR sequences were used for anatomical imaging. Functional MRI and DTI processing, image coregistration and neuronavigation integration were performed using BrainLab iPlan 2.6, and Brainwave PA software systems. In two patients awake craniotomy with cortical language mapping was used, and in four patients cortical motor stimulation was performed. Correlation with operative findings, pathology, resection extent, and surgical outcome was performed.

RESULTS
Average age was 49 years with 6 females and 10 males. All were right handed. All mass lesions were involving or near areas of eloquent cortex or white matter tracts, 14 in the left hemisphere. Pathology included: anaplastic astrocytoma (7), GBM (5), oligodendrogliaoma (3), lymphoma (1). Functional MRI and DTI data were acquired successfully and integrated in all patients. In the patients who underwent awake craniotomy there was excellent correlation with areas of fMRI activation related to language tasks and speech arrest or errors during cortical stimulation. Gross total resection was achieved in 10, subtotal in six. Postoperatively, eight patients were normal or neurologically stable, five patients had mild new deficits, and three patients had moderate new deficits. Neuronavigation was successful and deemed highly useful in all cases for operative planning and resection guidance.

CONCLUSION
Functional MRI and tractography are highly useful in patients with brain tumors near or involving eloquent brain regions. Utilization of a comprehensive preoperative fMRI and tractography assessment protocol at 3 T with neuronavigation integration allows for both preoperative planning and intraoperative guidance of resection. There was good correlation with findings of intraoperative cortical stimulation. In our group, most patients received gross total resection of tumor, and 13/16 had no or only mild new deficits after surgery.

KEY WORDS: fMRI, tractography, tumor

Paper 219 Starting at 4:34 PM, Ending at 4:42 PM
Functional MR Imaging for Preoperative Surgical Planning in Brain Tumor Patients
Arredondo, N. F. · Houseknecht, K. · Murtagh, F. R. · Brem, S.
University of South Florida
Tampa, FL

PURPOSE
In patients with brain tumors in eloquent cortex, maximal safe resection can be difficult to achieve without extensive intraoperative maneuvers such as awake craniotomy and cortical mapping. Preoperative planning may be performed with standard blood oxygenation level-dependent (BOLD) functional magnetic resonance imaging (fMRI) scanning technique and used in conjunction with commercially available MRI-based intraoperative stereotactic guidance. When appropriate, somatosensory evoked potential (SSEP) monitoring can be employed to confirm motor and sensory cortex.
Previous authors have published small series of patients to report on the safety of these techniques. Here we report a large series of patients from a single institution with long term follow up.

**MATERIALS & METHODS**

We performed a retrospective chart review and identified 234 patients who underwent a resective craniotomy for either primary or secondary brain tumor in eloquent cortex at our institution from July 2002 until December 2005. The patients all underwent preoperative BOLD fMRI with intra-operative MRI-based stereotactic guidance. When appropriate, patients also underwent intraoperative SSEP confirmation of sensory and motor cortex.

**RESULTS**

Standard outcome measures included neurologic deficit, Karnofsky performance score (KPS), Eastern Cooperative Oncology Group performance status (ECOG), and Radiation Therapy Oncology Group recursive partition analysis (RTOG-RPA). Data also was collected regarding secondary outcome measures including length of hospital stay, operative and nonoperative complications and the patient’s prior or subsequent chemotherapy and radiation therapy treatments. Based upon these outcome measures, we found that this population of patients who underwent resection of tumor in eloquent cortex had generally good outcomes with very few new postoperative deficits.

**CONCLUSION**

Based upon the experience at our institution with a large number of patients and with a long follow-up period, we find that preoperative planning with BOLD fMRI used in conjunction with intraoperative stereotactic guidance and confirmed with SSEP provides a reliable, effective, and safe technique for surgical resection of brain tumors in eloquent cortex.

**KEY WORDS:** fMRI, brain tumors, neuronavigation

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**Paper 220 Starting at 4:42 PM, Ending at 4:50 PM**

**Should Diffusion Tensor Imaging Mapping Be Required for All Brain Surgery Patients?**

Maheshwari, M.1 · Ulmer, J. L.1 · Muller, W. M.1 · Krouwer, H. G.2 · Mark, L. P.1 · Daniels, D. L.2 · Gill, S.1 · DeYoe, E. A.1 · Hacein-Bey, L.2 · Sinson, G1 · Malkin, M. G.1 · Kurpad, S. N.1

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**PURPOSE**

To determine the predictive value for proximity risk assessments for eloquent white matter in neurosurgical patients, using only conventional MR imaging (MRI).

**MATERIALS & METHODS**

Conventional brain MRI images and presurgical diffusion tensor imaging (DTI) mapping data of 88 consecutive neurosurgical patients (48 males and 40 females, 5 - 86 yrs old) were analyzed prospectively and independently by two functional neuroradiologists experienced in clinical DTI. The predictive value of conventional MRI in determining 1) the immediate proximity (within 5mm) or direct involvement of eloquent white matter, and 2) specific border proximities to eloquent white matter were compared to actual proximities determined at color-coded directional DTI maps. Functional white matter tracts of interest included motor tracts from the precentral gyrus through the posterior limb of internal capsule, speech/language fibers in the superior longitudinal fasciculus (SLF), and vision fibers in the optic radiation (OR). Lesions included 71 tumors, 9 arteriovenous malformations, 7 cavernous malformations, and 1 undiagnosed lesion. Lesion sizes ranged from 1-11cms.

**RESULTS**

The predictive value (Table 1) of conventional MRI alone in determining proximity to, or involvement of, any white matter tract of interest had overall sensitivity of 94.6%, specificity of 94.8%, PPV of 95.9%, and NPV of 93.2%. However, the predictive value was dependent on white matter structure of interest, with the predictive value for SLF proximity being the poorest. Border-risk assessments were inaccurate in the majority of patients and were accurately predicted on conventional MRI in only 43% of functional systems (Table 2).

**KEY WORDS:** DTI, presurgical brain mapping, brain tumors

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**Paper 221 Starting at 4:50 PM, Ending at 4:58 PM**

**Withdrawn**
Tuesday Afternoon  
3:30 PM – 5:00 PM  
Room 206/207  

(28b) PEDIATRIC: Epilepsy, Inflammatory, Infectious Diseases/Excerpta  
(Scientific Papers 222 – 234)  

See also Parallel Sessions  
(28a) ADULT BRAIN: Functional Imaging/MRI  
(28c) HEAD & NECK: Pharynx, Larynx, Soft Tissue, Sinonasal & Other  
(28d) SPINE: Spine Interventions, Vascular Lesions and Vertebroplasty I  

Moderators: Noriko Salamon, MD  

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Paper 222 Starting at 3:30 PM, Ending at 3:38 PM  
Bilateral Diffusion Tensor Abnormalities of Temporal Lobe and Cingulate Gyrus White Matter in Children with Temporal Lobe Epilepsy  

Widjaja, E. 1 · Go, C. 1 · Rutka, J. T. 1 · Rydenhag, B. 2 · Mabbott, D. J. 1 · Snead, O. C. 1 · Raybaud, C. 1 · Nilsson, D. 1  
1Hospital for Sick Children, Toronto, ON, CANADA,  
2Sahlgrenska Academy at Göteborg University, Göteborg, SWEDEN  

Purpose  
Bilateral diffusion tensor imaging (DTI) abnormalities have been reported in the white matter associated with the hippocampus in adults with mesial temporal lobe epilepsy (TLE). In children with a shorter duration of epilepsy, such changes may not have emerged yet. The aim of this study was to investigate interictal changes in the temporal lobe white matter (TLWM) and cingulate gyrus white matter (CGWM) of children with TLE using DTI.  

Materials & Methods  
Diffusion tensor imaging was performed in eight children with TLE and ten healthy, age-matched controls. Fractional anisotropy (FA), trace, parallel and perpendicular diffusivity were calculated for a volume of interest in the TLWM and CGWM on the seizure focus side and the contralateral side. Data were compared for differences between sides for patients and between patients and controls.  

Results  
There were no significant differences in FA, trace, parallel and perpendicular diffusivity between left and right side in the control group (p>0.05). There were also no significant differences in FA, trace, parallel and perpendicular diffusivity between TLWM and CGWM on the seizure focus side versus the contralateral side in TLE patients (p>0.05). Significantly increased trace, parallel and perpendicular diffusivity were found in the TLWM and CGWM of TLE patients compared to controls (p<0.01). However, there was no significant difference in FA in the TLWM and CGWM of TLE patients compared to controls (p>0.05).  

Conclusion  
Bilaterally increased trace, parallel and perpendicular diffusivity in the white matter in children with TLE may be related to seizure induced functional or structural changes. The preserved FA in our pediatric cohort was in contrast to the reduced FA reported in the white matter of adults with TLE and may relate to differences in the duration of epilepsy or in the vulnerability of white matter to seizures.  

Key Words: Temporal lobe epilepsy, DTI, pediatric  

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Paper 223 Starting at 3:38 PM, Ending at 3:46 PM  
Diffusion Tensor Imaging to Identify Cortical Dysplasia in Epilepsy Patients  

Salamon, N. · Kung, J. · Wu, J. · Koh, S. · Sankar, R. · Mathern, G.  
University of California Los Angeles  
Los Angeles, CA  

Purpose  
Focal cortical dysplasia (FCD) is the most common cause of pediatric intractable epilepsy. For the 30% of epilepsy patients who cannot be treated with medication, surgical resection is an effective therapy. If the lesion is defined with MRI, postoperative seizure control is seen in 70% of cases. However, subtle types of cortical dysplasia may be difficult to see on MRI. Diffusion tensor imaging (DTI) is a sensitive measure of the subtle water molecule changes in the gray and white matter of the brain. Fraction anisotropy (FA) (the degree of directionality of the tissue), and apparent diffusion coefficient (ADC) (extent of random water diffusion in tissue) are the two parameters obtained by DTI. We hypothesize that DTI may be sensitive for identifying cortical disorganization and white matter tract changes in FCD patients. Purpose of the study is to evaluate ADC and FA of FCD lesion versus contralateral/ nonlesion side in surgically proved FCD patients. Also, evaluate white matter tracts of FCD patients versus normal age-matched controls.  

Materials & Methods  
Nineteen cases (M: F=10:9, average age 11 years) of surgically proved FCD between 2003 and 2006 were analyzed with a 1.5 T Siemens Sonata Scanner. Ten cases had Palmini type II FCD (Taylor), and nine cases had type I FCD (Non-Taylor). b=0 and b=1200, 12 direction (5mm/ low resolution slice) and b=0 and b=700, 6 direction (2mm/ high resolution slice) DTI were obtained. DTI Studio software was used for postprocessing to obtain FA and ADC values. Two analyses were performed: 1.Comparison of the difference between white matter and gray matter FA and ADC values in the
region of FCD versus the contralateral side. 2. Comparison of FA and ADC values in key white matter tract regions of 19 FCD patients versus 9 age-matched normal controls. Six regions were sampled: genu and splenium of the corpus callosum, anterior and posterior limbs of the left and right internal capsules. These regions appear normal on conventional MRI.

RESULTS
The difference in ADC and FA between gray and white matter of FCD was significantly lower than contralateral side. ADC and FA values in the splenium of the corpus callosum differed significantly between type II FCD patients and normal controls but not with type I FCD patients.

CONCLUSION
Diffusion tensor imaging is helpful for detecting the ADC and FA values of the difference between gray and white matter are lower in the dysplastic tissue compared to the contralateral side. Morphologically “normal” splenium of the corpus callosum shows lower FA and higher ADC in type II FCD patients.

KEY WORDS: Cortical dysplasia, epilepsy, DTI

Paper 224 Starting at 3:46 PM, Ending at 3:54 PM
Diffusion Tensor Imaging in Tuberous Sclerosis: Pathological Correlation

Salamon, N. · Pramanik, S. · WU, J. · Koh, S. · Sankar, R. · Mathern, G · Vinters, H.
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Los Angeles, CA

PURPOSE
Tuberous sclerosis complex (TSC) is an autosomal dominant disease which affects multiple organ systems and has various clinical neurologic manifestations. Approximately 90% of TSC patients have epilepsy and up to 25-30% will have intractable epilepsy. Epileptogenic zone is known to be the tissue adjacent to the tubers. We previously found FDG-PET showed larger area of hypometabolism in the epileptogenic tuber. The patients with TSC previously were shown to have decreased cerebral volumes than age-matched controls. The purpose of the study is to evaluate ADC and FA changes in the area of larger hypometabolism compared to the area of normal metabolism to assess tissue integrity using diffusion tensor imaging (DTI) and to evaluate if there are any differences in ADC and/or FA values in large white matter tracts such as the corpus callosum and internal capsule in TSC patients and age-matched normal controls.

MATERIALS & METHODS
Eighteen TSC patients (M: F / 8:10 mean age 4.9 year old) with intractable epilepsy were included in the study. Diffusion tensor imaging was performed using b=0 and b=1200, 12 direction (5mm/ low resolution slice) and b=0 and b=700, 6 direction (2mm/ high resolution slice). Diffusion tensor imaging Studio software was used for post-processing to obtain FA and ADC values. Regions of interest (ROI) were drawn in gray and white matter in hypometabolism without demonstrating a significant MRI abnormality. In the white matter tracts, there are significantly increased ADC value in genu and splenium of the corpus callosum.

CONCLUSION
Diffusion tensor imaging will be helpful for evaluating TSC patient.

KEY WORDS: Tuberous sclerosis, epilepsy, DTI

Paper 225 Starting at 3:54 PM, Ending at 4:02 PM
Alteration of Diffusion Tensor Parameters on Postmortem Brain

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PURPOSE
There is an increasing interest in comparing DTI tractography in autopsy specimens with histological findings. In autopsy of humans, there is usually an interval of hours to days between death and tissue fixation, during which the cadaver is stored below room temperature to retard tissue autolysis. However, it is unclear as to the duration in which the DTI characteristics of white matter are maintained postmortem. We have attempted to model this process and evaluate the alteration in measures of fractional anisotropy (FA), trace and eigenvalues of the postmortem brain in pigs.

MATERIALS & METHODS
Six Yorkshire piglets were scanned under general anesthesia whilst they were still alive. Following intraperitoneal injection of pentobarbitol, the pigs were decapitated and the brains remained in the skull and were kept at 4°C. The brains were scanned at 3, 6, 9, 12, 18, 24, 30, 36, 42, 48 and 72 hours following death using single shot DTI on a 1.5 T MR. Regions of interest (ROI) were placed in the corpus callosum, internal capsule, periventricular white matter anteriorly and posteriorly and subcortical white matter anteriorly and posteriorly. The mean FA, trace, major, medium and minor eigenvalues (λmajor, λmedium and λminor) were assessed. Comparison was made on the FA, trace and eigenvalues of the corpus callosum, internal capsule, periventricular and subcortical white matter when the pigs were alive and at 3 hours postmortem.

RESULTS
There was a slight increase in FA, particularly in the first 3 hours postmortem, of the corpus callosum, internal capsule, periventricular and subcortical white matter. The FA remained stable up to 72 hours postmortem. There was a
marked decrease in trace of the corpus callosum, internal capsule, periventricular and subcortical white matter in the first 3 hours following death. Whilst the λmajor, λmedium and λminor all declined with time, particularly in the first 3 hours, λminor demonstrated the largest decline with time. There was a nonlinear relationship of FA, trace and eigenvalues with postmortem time.

**CONCLUSION**

We have found that FA did not change significantly in the first 3 days postmortem when the brain was kept at 4°C. This study supports the utility of measuring diffusion anisotropy if the time elapsed between death and tissue fixation is within 3 days. However, trace and eigenvalues decreased markedly within the first few hours postmortem. Therefore trace and eigenvalues obtained from ex vivo studies cannot be extrapolated to in vivo studies.

**KEY WORDS:** Postmortem, DTI, brain

**Paper 226 Starting at 4:02 PM, Ending at 4:10 PM**

**MR Imaging and Proton Spectroscopic Findings in Children with Developmental Delay**

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Royal Hallamshire Hospital, Sheffield, UNITED KINGDOM, Sheffield Children’s Hospital NHS Foundation Trust, Sheffield, UNITED KINGDOM, University of Sheffield, Sheffield, UNITED KINGDOM

**PURPOSE**

There is debate in the literature when and if cerebral imaging should be performed in children with developmental delay, particularly if isolated (developmental delay in children with no causative history or neurologic signs). When cerebral imaging is performed there is a consensus that magnetic resonance (MR) imaging is the preferred modality but there is varying opinion as to whether proton spectroscopy is useful in unselected cases. The purpose of this study was to determine the frequency of MR and proton spectroscopy abnormalities in unselected children with developmental delay.

**MATERIALS & METHODS**

Consecutive children referred to Sheffield Children’s Hospital with developmental delay for MR imaging of the brain between January 2007 and December 2007 were included in this prospective study. Permission was given by Sheffield Children’s NHS Trust institution review board. All children had axial T2-weighted, coronal FLAIR and a coronal T1-weighted volume imaging of the whole brain. Proton spectroscopy (single voxel technique) was performed over the left basal ganglia and left parietal occipital white matter. Questionnaires were sent to the referring clinicians and medical notes were reviewed to gauge the usefulness of the imaging in determining the etiology of developmental delay and the effect of imaging on patient management. The type of developmental delay and any additional symptoms (seizures, macrocephaly, microcephaly, focal neurology and regression) were recorded.

**RESULTS**

Sixty-four children with developmental delay have been imaged to date. Two of 64 were excluded as imaging was incomplete. The mean age was 71 months and 27/62 were female. Forty-two of 64 (68%) had completely normal MR imaging. Fourteen of 64 (22%) had a nonspecific abnormality such as reduced white matter volume, delayed myelination, nonspecific white matter abnormality or cavum septum pellucidum. Six of 62 (10%) had a specific abnormality indicative of a particular condition or etiology (1 septo optic dysplasia with bilateral schizencephaly, 1 neonatal hypoglycaemia, 2 periventricular leukomalacia, 1 gray matter heterotopia and 1 leukodystrophy). Fifty-eight of 62 (94%) had normal proton spectroscopy. Four of 62 (6%) had abnormal spectroscopy of which two indicated low creatine levels. One child had a low basal ganglia N-acetyl aspartate/creatine ratio and an elevated parietal occipital white matter N-acetyl aspartate/creatine ratio with an increased myoinositol peak in both regions of interest. Low basal ganglia and parietal occipital white matter N-acetyl aspartate/creatine ratios were reduced in the fourth case.

**CONCLUSION**

MR imaging is useful in detecting abnormalities in children with developmental delay with nearly one third of referrals demonstrating an abnormality on cerebral MR imaging. Proton spectroscopy can provide additional useful information to standard imaging sequences in a small proportion of unselected children with developmental delay.

**KEY WORDS:** Developmental delay, MRI, spectroscopy

**Paper 227 Starting at 4:10 PM, Ending at 4:18 PM**

**Effect of Marijuana on Adolescent Brain: A Voxelwise Diffusion Analysis with Fiber Tractography**

Ashtari, M. · Cervellione, K. · Cottone, J. · Kester, H. · Roofeh, D. · Ardekani, B. · Kumra, S.

Children’s Hospital of Philadelphia, Philadelphia, PA, Jamaica Hospital Medical Center, Jamaica, NY, North Shore LIJ Health Systems, Glen Oaks, NY, University of Denver, Denver, CO, Nathan Kline Institute of Psychiatry, Orangeburg, NY, University of Minnesota, Minneapolis, PA

**PURPOSE**

Marijuana consumption remains quite common with increasing rate of use in both developed and developing countries. Adolescence is the time when experimentation with marijuana often begins. Despite known widespread marijuana use, especially in adolescents, knowledge about its effects on the developing human brain remains limited. This study evaluates marijuana effect on the brain using DTI voxel-based and tractography analysis.

**MATERIALS & METHODS**

Fourteen heavy marijuana users (HMU) were recruited from a drug-treatment rehabilitation facility and met DSM-IV diagnostic criteria for marijuana dependence. Subjects had an average daily use of 5.8 joints per day with report of daily marijuana use for at least 1 year prior to treatment. Fourteen healthy controls were matched in age, gender, SES, and handedness to the HMU but differed significantly in IQ (p<.02). All subjects underwent a 15-direction isotropic diffusion imaging. Following intersubject registration of the
fractional anisotropy (FA), radial diffusivity, axial diffusivity and trace maps, voxelwise ANCOVA (VANCOVA) was performed controlling for IQ. Tractography was performed to extract the left and right superior longitudinal fasciculi (SLF) and the motor fibers as control tracts using DTIStudio.

**RESULTS**

VANCOVA analyses showed compared to normal controls, HMU had clusters of decreased FA in the bilateral posterior internal capsule/thalamic radiations and bilateral temporal gyri (p<0.001, cluster size ≥100 voxels). Clusters with increased radial diffusivity and trace values appeared in the homologous areas with decreased FA in the left thalamic radiation and bilateral temporal gyri (Figure). The average values of diffusion parameters along the left and the right SLF showed similar patterns of abnormality (reduced FA, increased radial diffusivity and increased trace values). No significant changes were found for the right and the left motor fibers.

**CONCLUSION**

In addition to risk taking age for marijuana experimentation, adolescence is also a critical period for brain maturation and the development of neural pathways. Our data suggests that recurrent exposure to marijuana is associated with white matter abnormalities in key brain regions that are undergoing significant changes during late adolescence in normal controls (1). Patterns of alterations in diffusivity parameters in the temporal gyri suggest abnormalities in myelination process of heavy marijuana users. Heavy consumption of marijuana, especially during early adolescence, may disrupt normal brain development and slow brain maturation process.

**REFERENCES**

1. Ashtari, et al. 2007

**KEY WORDS:** Marijuana, DTI, tractography
CONCLUSION
Clinically useful PWI can be obtained with low dose GBCA (0.05mmol/kg) at 1.5 T and 3.0 T. When PWI is combined with DEMRI evaluations, which require a separate injection of contrast, lower dose PWI may permit total GBCA dose administration to equal the FDA recommended dosage of 0.1mmol/kg. Similarly, it may be prudent to use lower PWI dosing when there are risk factors for NSF.

KEY WORDS: Perfusion imaging, pediatrics, nephrogenic systemic fibrosis

Paper 229 Starting at 4:26 PM, Ending at 4:34 PM

Pediatric MR Imaging Automated Spine Survey Iterative Scan Technique

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PURPOSE
While it is widely acknowledged that x-ray exposure should be reduced as much as possible, particularly in the sensitive pediatric population, exposure to diagnostic ionizing radiation continues to increase (1). We developed and tested an automated MRI technique to provide subminute, submillimeter in-plane resolution screening of the entire spine as a rapid non-ionizing alternative to x-ray or CT scanning in children and as an optimized localizer for more focused MR imaging.

MATERIALS & METHODS
The entire spine was auto-imaged at 3.0 T in two contiguous 35 cm FOV sagittal stations (11 sections, 4mm skip 1mm), utilizing out-of-phase FGRE sequencing (TR/TE = 57/1.4 ms, flip angle =30, BW = +/- 62.5 kHz, 512 x 352 matrix, 21 sec breath hold). Between March-July 2007, 13 school age children (ages 7 - 18 years, mean = 13, 5 females, 8 males) were studied for a wide range of indications including scoliosis (Figs 1c, f). Images were evaluated independently by a neuroradiologist with CAQs and run through ASSIST (2) analysis software for automated vertebral and disk numbering.

RESULTS
In 12/13 (92.3%) total spine studies, computer ASSIST labeling was concordant with independent neuroradiologist assignments, including two children exhibiting 25 rather than the typical 24 mobile pre-sacral vertebrae (Fig 1d). ASSIST labeling failed in the child with greatest scoliosis, 37 degrees dextro-curvature centered at T6 (Fig 1c). In all cases, good contrast was achieved between vertebrae, disks, CSF, and neural tissue. Developmental changes were evident throughout the age spectrum studied with significant skeletal maturation delay noted in a 10-year-old girl (Fig 1b).

CONCLUSION
ASSIST is a promising MRI technique for pediatric imaging; affording a rapid automated high resolution, high contrast survey of the entire spine. More comprehensive testing is warranted to assess the technique’s sensitivity and specificity over a wide gamut of pathology.

REFERENCES
2. Weiss KL, Storrs JM, Banto RB. ASSIST. Radiology 2006;239:255-262

Acknowledgments: Supported by the State of Ohio Child Care Fund.

KEY WORDS: Pediatrics, spine, MRI
Eosinophilic Meningoencephalitis Secondary to Raccoon Roundworm (*Baylisascaris procyonis*) Infection

Cully, B. 1,2 · Lowe, L. H. 1,2

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**Purpose**
Discuss the clinical presentation, pathology, epidemiology, and neuroimaging findings of raccoon roundworm (*Baylisascaris procyonis*) encephalitis.

**Case Report**
A previously healthy 18-month-old female developed fever and progressive neurologic decline over a 2-week period. Initial corticosteroid and antibiotic therapy for suspected bronchitis was unsuccessful. The patient became obtunded and was admitted to the intensive care unit for work up and treatment of meningitis. MR imaging demonstrated periventricular white matter disease. Subsequent peripheral blood and cerebrospinal fluid sampling revealed eosinophilia. Serologic testing confirmed *Baylisascaris procyonis* infection. Despite antihelminthic and immunosuppressive therapy, the patient continued to deteriorate and remains neurologically devastated.

**Imaging Findings**
Initial MR imaging of the brain performed 10 days following the onset of illness revealed patchy multifocal areas of edema involving the subcortical and deep white matter, cortex, thalami, and basal ganglia. Scattered areas of restricted diffusion also were present throughout the cerebral cortex. Two subsequent MR examinations of the brain performed over the next 5 weeks demonstrated progressive cerebral volume loss and extensive white matter disease.

**Summary**
*Baylisascaris procyonis* infection can result in severe encephalitis and neurologic devastation. In the clinical setting of potential exposure to the pathogen, eosinophilia, and imaging findings of periventricular white matter disease, the diagnosis of raccoon roundworm encephalitis should be considered.

**Key Words:** Meningoencephalitis, raccoon roundworm, *Baylisascaris procyonis*

Central Nervous System Manifestations of Juvenile Xanthogranulomatosis

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**Purpose**
Non-Langerhans cell histiocytoses (non-LCH) consists of a spectrum of diverse disorders differentiated on the basis of immunophenotype. We present a case of an unusual type of non-LCH, systemic juvenile xanthogranulomatosis (JXG), with involvement of the paravertebral soft tissues, lungs, and leptomeninges of the craniospinal axis. To the best of our knowledge, this is the first such reported case of extensive central nervous system (CNS) involvement.

**Case Report**
We report a case of a previously healthy male infant who at 3 months developed progressive, infiltrative, nodular lesions on the scalp, face, right inguinal area, and right thigh. Skin biopsy was nonspecific but suggested a histiocytic proliferative disease. The patient was admitted for extensive hematologic and oncologic evaluation, including CT of the chest, abdomen and pelvis and MRI of the craniospinal axis. During hospital admission, the patient underwent a bone marrow biopsy and CT-fluoroscopically guided biopsy of thoracic paraspinal masses. The bone marrow biopsy showed histiocytic proliferative disorder. The paraspinal masses revealed systemic juvenile xanthogranulomatosis, a form of non-LCH.

**Imaging Findings**
The chest CT demonstrated multiple masses in both lungs and a right paraspinal mass adjacent to the right posterior 8th rib. No abdominal or pelvic mass was identified. Magnetic resonance imaging of the brain showed signal abnormality and leptomeningeal enhancement along the brainstem and ventral cerebellum. The spinal MRI demonstrated diffuse leptomeningeal enhancement of the entire cord, including cauda equina. There was mild expansion and signal abnormality of the cervical cord and distal spinal cord, most evident at the conus medullaris, which was postulated to be related to venous congestion or possible parenchymal infiltration. On the thoracic spine MRI, there were bilateral paraspinal masses at T8-T9, with extension of the right-sided paraspinal mass into the epidural space of the lateral spinal canal. The differential considerations for the conglomerate of imaging findings would include a small round blue cell tumor, such as neuroblastoma, primitive neuroectodermal tumor, and lymphoma. However, given the finding of histio-
cytosis on the prior biopsy of one of the subcutaneous lesions, some form of disseminated histiocytic disease, such as non-LCH or histiocytic sarcoma, also was considered.

SUMMARY
Our case of systemic JXG with cutaneous and extracutaneous manifestations, primarily extensive CNS involvement simulating malignancy, illustrates the diagnostic dilemma posed. Juvenile xanthogranulomatosis is in the family non-LCH, which can present differently due to stage of maturation of the precursor cell. Diagnosis is made on immunohistochemistry and clinical presentation (i.e., solitary, multiple).

KEY WORDS: Susceptibility-weighted imaging, brain

Paper 232 Starting at 4:44 PM, Ending at 4:49 PM
Amebic Encephalitis in a 2-Year-Old Male: Case Report and Presentation of MR Imaging Findings

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University of Kentucky
Lexington, KY

PURPOSE
Report the clinical and MR findings of a case of amebic encephalitis occurring in an otherwise healthy 2-year-old male.

CASE REPORT
We will present the clinical and MR findings of a case of amebic encephalitis occurring in an otherwise healthy 2-year-old male.

IMAGING FINDINGS
MR imaging of the head revealed diffuse, nodular leptomeningeal enhancement within the basal cisterns, as well as abnormal enhancement of the ependymal lining of the ventricles. There were several poorly parenchymal abnormalities with mass-like features. The abnormalities progressed quite rapidly on serial MR imaging. Biopsy and CSF cultures confirmed the diagnosis of Balamuthia mandrillaris amebic encephalitis.

SUMMARY
Amebic infection is a rare and often fatal cause of encephalitis. As in our case, definitive diagnosis often is made only by surgical biopsy. Amebic encephalitis should be considered within the differential diagnosis of leptomeningeal and parenchymal inflammatory/infectious processes.

KEY WORDS: Amebic, encephalitis, MRI

Paper 233 Starting at 4:49 PM, Ending at 4:57 PM
CT in Infant Dysphagic Choking Acute Life Threatening Event as a Mimic of Nonaccidental Injury

Barnes, P. • Galaznik, J. • Krasnokutsky, M. • Plunkett, J. • Ophoven, J. • Willey, E. • Nichols, G. • Shuman, M. • Stephens, P. • Squier, W.
1Lucile Salter Packard Children's Hospital at Stanford, Palo Alto, CA, 2University of Alabama Health Sciences, Tuscaloosa, AL, 3Madigan Army Medical Center, Tacoma, WA, 4Minnesota Regional Medical Examiners Office, Welch, MN, 5St. Louis County Medical Examiner, Duluth, MN, 6Medical Consultant, Saint Petersburg, FL, 7University of Louisville College of Medicine, Louisville, KY, 8Miami-Dade County Medical Examiner, Miami, FL, 9Forensic Pathology Consultant, Burnsville, NC, 10John Radcliffe Hospital, Oxford, UNITED KINGDOM.

PURPOSE
To describe the CT findings in infant dysphagic choking acute life threatening events (ALTE) as a mimic of nonaccidental injury (NAI).

MATERIALS & METHODS
The clinical data in 11 infants (ages 5 weeks - 11 months; mean 4.75 months) with dysphagic choking ALTE (fatal in 10) were compiled by a single reviewer (JGG) including 911 tapes, EMT records, caregiver interviews, medical records, and child protection service records. The initial brain CTs (<5 hours postevent) were reviewed independently by two neuroradiologists (PB, MK). Autopsy data (10) from the medical examiners reports were rereviewed by six independent pathologists (JP, JO, MS, PS, GN, PS).

RESULTS
In each case, there was acute onset, while awake, of choking, gagging and/or respiratory compromise with deterioration to apnea. Premorbid histories were severe gastroesophageal reflux disease (1), sickle cell disease (1), prior fall (1), birth trauma (1), and macrocephaly (1). No history or conclusive evidence of acute impact trauma was found while in the hospital. Bilateral retinal hemorrhages were present in 11, hypothermia in 7, and DIC in 5. CT findings included no fracture or evidence of extracranial swelling (11), variable diffuse cerebral edema (11), intraventricular hemorrhage (3), small interhemispheric hemorrhage (6), small convexity extracerebral hemorrhage (7), larger extracerebral hemorrhage (1). Average post ALTE survival until physical death was 42 hours (range 8-114 hours). Autopsy findings included hypoxic/ischemic injury (11), no neck or cervical spinal...
injuries (11), no impact sites (11), no traumatic axonal injury (11), acute subdural/subarachnoid hemorrhage (11), and neomembranes (4).

**CONCLUSION**

In the evaluation of ALTE, documentation of a dysphagic choking event can explain retinal hemorrhages, HIE, and variable degrees of extracerebral hemorrhage, including interhemispheric hemorrhage.

**REFERENCES**


**KEY WORDS**: ALTE, nonaccidental injury, hypoxia-ischemia

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**Paper 234 Starting at 4:57 PM, Ending at 5:02 PM**

**Intradiploic Cerebrospinal Fluid Pseudocyst: Unusual Complication of the Ventriculoperitoneal Shunt**

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Iowa City, IA

**PURPOSE**

Various complications of ventriculoperitoneal shunt for the treatment of hydrocephalus have been reported, which encompass from more commonly encountered entities such as tube disconnection/obstruction, infection, intraperitoneal CSF pseudocyst and ascites, to the more ethoteric ones such as bowel perforation, pleural effusion and extrusion of the peritoneal end of the tube through the anus/vagina, to name a few. We present an unusual case of progressively enlarging intradiploic CSF loculation (pseudocyst) involving the occipital bone caused by rostral migration of the reservoir of the ventriculoperitoneal/cystoperitoneal shunt.

**CASE REPORT**

A 15-year-old boy presented for a checkup prior to enrollment on a football team. His medical history included diagnosis of Dandy-Walker cyst with hydrocephalus, requiring ventriculoperitoneal shunt at the age of 6 months. At the age of 5 years, he underwent placement of a posterior fossa Dandy-Walker cystoperitoneal shunt connecting to the VP-shunt through the Y-connector. At the time of presentation, he is asymptomatic without headache and his neurologic examination was normal.

**IMAGING FINDINGS**

The skull radiographs showed markedly expanded occipital bone with thinning and focal erosive changes of the inner and outer tables. The reservoir of the posterior fossa cystoperitoneal shunt had migrated into the markedly expanded diploic space. On CT, intradiploic location of the reservoir was verified and expansion of the diploic space was noted to extend into the basioccipital as well as supraocciptal position. It was advised that he did not participate in the contact sports activity.

**SUMMARY**

CSF loculation (pseudocyst) in the diploic space of the calvarium is an extremely rare complication of the ventriculoperitoneal/cystoperitoneal shunt and has not been reported previously in imaging literature to our knowledge. Preexisting thinning of the occipital bone because of Dandy-Walker malformation and rostral migration of the reservoir were thought to be the cause of progressively enlarging intradiploic CSF pseudocyst.

**KEY WORDS**: Intradiploic cyst, ventriculoperitoneal shunt, CT
**Paper 235 Starting at 3:30 PM, Ending at 3:38 PM**

**Multiphasic, Multidetector CT-Enhancing Characteristics of Recurrent Thyroid Cancer**

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The University of Texas M.D. Anderson Cancer Center
Houston, TX

**PURPOSE**

A description of the enhancing characteristics of recurrent thyroid cancer by means of multiphasic, multidetector CT.

**MATERIALS & METHODS**

Thirteen cases of pathologically proved (6 FNA, 5 surgery, 2 thyroid cancer by means of multiphasic, multidetector CT. A description of the enhancing characteristics of recurrent Thyroid, cancer by means of multiphasic, multidetector CT. Several distinct patterns are described with early indications that this might be correlated to histology.

**KEY WORDS:** Thyroid, cancer, MDCT

**RESULTS**

Median age at examination was 61.9 years (IQR: 57.2 to 71.4 years; 70% male). Based upon the established level-specific size criteria for the axial plane, 56% of the nodes identified were classified as “enlarged” in the axial plane compared to 64% in the coronal and sagittal planes. Although linear correlation for “longest dimension” was reasonable ($r = 0.71$, $p<0.001$), classification concordance between the axial and both the coronal and sagittal planes was poor, with no evidence of systematic misclassification (axial versus coronal: kappa = 0.22, McNemar’s $p = 0.45$; axial versus sagittal: kappa = 0.12, McNemar’s $p = 0.48$). Only 41% of nodes were classified as enlarged in all three planes, although 78% of nodes were classified as enlarged in at least one plane. Of note, there was excellent agreement when comparing coronal with sagittal measures ($r = 0.97$, $p<0.001$; kappa = 0.9; McNemar’s $p = 1.0$).

**CONCLUSION**

There is little agreement in the categorization of lymph node “enlargement” using the axial versus the cranial-caudal dimension. Although evaluation of lymph nodes in all three planes may ultimately improve the radiologic detection of malignant lymphadenopathy, additional studies with
histopathologic correlation are needed to confirm the clinical relevance of such differences, and to establish the appropriate cranial-caudal cut-off values.

**Key Words:** Head and neck carcinoma, lymphadenopathy, CT

**Paper 237 Starting at 3:46 PM, Ending at 3:54 PM**

**RECISTing the Neck: Interobserver Variability in the Use of the Response Evaluation Criteria in Solid Tumors for Head/Neck Cancers**

Goradia, D. · Anzai, Y. · Shibata, D.
University of Washington
Seattle, WA

**Purpose**
The previously widespread World Health Organization (WHO) criteria for measuring and reporting tumors have been replaced gradually by the Response Evaluation Criteria for Solid Tumors (RECIST) criteria for purposes of treatment decision-making. There are some indications that the RECIST criteria may not be as reproducible as the WHO criteria (1-3). In this regard, head/neck cancers tend to have ill-defined margins and may pose a particular problem. The purpose of the study is to evaluate interobserver variability in the use of the RECIST criteria compared to the WHO criteria for reporting head/neck cancers.

**Materials & Methods**
All neck CTs obtained between July 1, 2005 and June 30, 2006 for head/neck cancer at our institution were obtained. Only those tumors that had not had surgery yet, and that had a pre and postchemo/radiation treatment scan were included. Two board-certified neuroradiologists blinded to each other reviewed the scans and measured the target lesions using both the RECIST and WHO criteria. Changes in measurements between the pre and posttreatment scans were categorized for each radiologist into one of four treatment response categories using standard criteria: complete response (CR), partial response (PR), stable disease (SD), progression of disease (PD). Weighted kappa values were calculated between the radiologists for the RECIST and WHO criteria, and between the RECIST and WHO criteria for each radiologist.

**Results**
For the pilot data, nine patients (18 scans) were reviewed, and a total of 24 lesions were measured with an average difference in measurement of 25% between the radiologists. For RECIST, weighted κ=0.40 with 77.8% agreement between radiologists; WHO, weighted κ=0.61 with 88.9% agreement between radiologists. For each radiologist, agreements between RECIST and WHO were 94.4% and 88.9% with weighted κ=0.81 and κ=0.70 respectively.

**Conclusion**
The pilot data suggest that for head/neck cancers, there is greater interobserver agreement between radiologists reviewing neck CTs when utilizing the WHO criteria ( bidimensional measurements) as compared to the RECIST criteria. We plan to review and present data for 50+ patients (100+ scans) at the meeting in order to provide validation for the above pilot data.

**References**

**Key Words:** RECIST, head/neck cancer

**Paper 238 Starting at 3:54 PM, Ending at 4:02 PM**

**Neurologic Complications of Preoperative Embolization of Arteriovenous Malformations**

Jayaraman, M. V. · Marcellus, M. L. · Do, H. M. · Chang, S. D. · Steinberg, G. K. · Marks, M. P. 2
1Warren Alpert School of Medicine at Brown University, Providence, RI, 2Stanford University, Stanford, CA

**Purpose**
Preoperative embolization of arteriovenous malformations has been employed by many centers to facilitate surgical resection. The purpose of this study was to determine the contribution of embolization to final posttreatment neurologic deficit when combined with surgery.

**Materials & Methods**
A retrospective review identified all patients treated during an 11-year span (1995-2005), who underwent embolization as first therapy for arteriovenous malformation (AVM) in advance of planned surgical resection as curative therapy. We recorded patient age, presenting symptoms, Spetzler-Martin grade of the AVM, as well as modified Rankin scores (mRs) pretreatment, postembolization but presurgical, postsurgical and late posttherapy. All patients were embolized with liquid embolic agents.

**Results**
We identified 83 patients who underwent a total of 189 embolization sessions. There were 5 Spetzler-Martin Grade I, 14 Grade II, 39 Grade III, 17 Grade IV and 8 Grade V AVMs. Pre and posttreatment modified Rankin scores are summarized in the table and graph below. Prior to treatment 74 patients (89.2%) were not significantly disabled (mRs 0-2). Following embolization 76 patients (91.6%) were mRs 0-2, and postsurgery this was 70 patients (84.3%). Of all patients, 70 (84.3%) had unchanged mRs after embolization, 8 (9.7%) improved, and 5 (6.0%) were worse. Two patients (2.4%) had new significant disability or died (mRs 3-6) postembolization. There were 6 patients (7.2%) who were dead or disabled (mRs 3-6) following surgery. Considering the combined course of treatment in the 74 patients who were mRs 0-2 pretreatment, 7 (9.5%) were mRs >2 post treatment, 2 following embolization and 5 following surgery. Table 1

<table>
<thead>
<tr>
<th>Modified rankin score</th>
<th>Pretreatment</th>
<th>Postembolization</th>
<th>Postsurgical</th>
<th>Final</th>
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<tr>
<td>0</td>
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<td>52</td>
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<td>6</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
CONCLUSION
Preoperative embolization of arteriovenous malformations can be performed with low treatment-related neurologic morbidity. Combined therapy does not appear to increase the rate of treatment-related complications reported for surgery alone (1).

REFERENCES

KEY WORDS: AVM, embolization

Paper 239 Starting at 4:02 PM, Ending at 4:10 PM
Fluorodeoxyglucose-Positron Emission Tomography/Computed Tomography Imaging in Patients with Carcinoma of the Larynx: What Does PET CT Add to the Overall Patient Evaluation?

Zacharia, T. · Kanekar, S. · Nguyen, D. · Kalapos, P. · Allen, T. · Goldenberg, D.
Penn State Hershey Medical Center
Hershey, PA

PURPOSE
Recent studies have suggested that FDG PET CT exceeds routine enhanced CT in sensitivity and specificity for the diagnosis of head and neck cancer. The purpose of this investigation is to assess the added diagnostic value of PET CT when performed after a diagnosis of larynx carcinoma on CT.

MATERIALS & METHODS
Retrospective review of imaging data base from 1/1/03 to 11/1/07 found 20 subjects (age 52-77 years; mean 62 years) with CT diagnosis of larynx cancer who subsequently underwent PET CT exam within 30 days of the routine neck CT. The study was approved by the Institutional Review Board (IRB). All subjects had scans performed at initial diagnosis. The PET CT examinations were interpreted in consensus by a head and neck radiologist and a nuclear medicine imager. All 20 subjects had histopathologic confirmation of diagnosis.

RESULTS
Of the 17 subjects confirmed by PET CT to have laryngeal cancer, 3 (3/17, 17.6%) had vocal cord tumors without supraglottic or subglottic extension, 5 (5/17, 29.4%) had supraglottic extension, 4 (4/17, 23.5%) had transglottic extension, 4 (4/17, 23.5%) had hypopharyngeal extension, and one had a preepiglottic extension. Mean standardized uptake values (SUVs) were 2.7 (range, 1.5-6.5) for (18)F-FDG in these 17 subjects. Three of the 20 subjects with CT suspicion of laryngeal cancer had no PET-CT evidence of malignancy (3/20, 15%). In these patients, the findings on CT were explained by an alternate diagnosis (chronic laryngitis (n=1), laryngeal polyp (n=1), laryngeal papilloma (n=1)). Additional neck findings not identified by CT were observed on PET in 7/20 (35%) patients. These included additional metastatic lymphadenopathy (n=4), apical lung lesions (n=2), second primary carcinoma in the tonsil (n=1). Thus seven CT false-negative tumors were detected by FDG-PET in seven different subjects.

Figure 1A. PET portion of a PET CT study in a subject with laryngeal cancer shows abnormally increased uptake in bilateral level 2 metastatic lymphnodes. Figure 1B. Routine contrast-enhanced neck CT performed 2 weeks earlier was interpreted as reactive level 2 lymphadenopathy.

CONCLUSION
PET CT provides important added information after CT diagnosis of larynx cancer in 50% of subjects by providing a diagnostic alternative in 15% and by providing supplementary diagnostic information in another 35% of subjects.

KEY WORDS: Larynx carcinoma, PET-CT, CT neck

Paper 240 Starting at 4:10 PM, Ending at 4:18 PM
Esthesioneuroblastoma: Initial Experience with F-18 FDG PET/CT Imaging

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1Beth Israel Medical Center, New York, NY, 2St. Luke’s-Roosevelt Hospital Center, New York, NY.

PURPOSE
To identify F-18 FDG PET/CT characteristics of esthesioneuroblastomas.

MATERIALS & METHODS
Eight patients with histologically proved esthesioneuroblastoma were evaluated with both MRI and FDG PET/CT.
RESULTS
Esthesioneuroblastomas are mildly hypermetabolic on F-18 FDG PET/CT. There is no significant difference in between the SUV value of the intracranial vs the sinonasal portion of the tumors. Leptomeningeal extension of esthesioneuroblastoma was detected on MRI only and not detected on PET/CT.

CONCLUSION
FDG PET/CT can be used for evaluation of metastatic disease in patients with esthesioneuroblastoma. The presence of metastatic disease potentially could alter treatment options. FDG PET/CT should not be used as a diagnostic imaging tool to differentiate this tumor from other sinonasal tumors or for evaluation of intracranial extension of tumor.

KEY WORDS: Esthesioneuroblastoma, PET

Paper 241 Starting at 4:18 PM, Ending at 4:26 PM
Severity of CT Findings of Sinus Inflammatory Disease in Patients following World Trade Center Dust Exposure
Prasad, R. S. · Pramanik, B. · Wang, E. · Amin, M. · Gonzalvez, J. · Nusbaum, A.
New York University
New York, NY

PURPOSE
The collapse of the World Trade Center (WTC) in 2001 resulted in a large-scale single event release of toxic fumes, chemicals, and particulate material into the environment. Symptoms of both upper and lower respiratory tract infections have been reported in individuals with variable WTC particulate matter exposure. The goal of this study was to assess the severity of computed tomographic (CT) findings of paranasal sinus inflammatory disease in patients with a history of WTC exposure as compared to a cohort of non-WTC exposed patients presenting with sinusitis.

MATERIALS & METHODS
More than 1000 patients presented to our tertiary care center’s WTC clinic that treated no-rescue workers for possible health effects of WTC dust exposure. Sinus CT scans were performed (axial and coronal 3mm slices) on those patients who presented with severe sinus disease and failed treatment. These scans were reviewed retrospectively. The sinus studies were graded using the Lund-Mackay scoring system with each sinus and ostiomeatal unit scaled on a ordinal scale of 0-2 (0 - no disease, 1 - mild opacification, 2 - near complete/complete opacification; maximum score of 24). These scores subsequently were subdivided into severity categories of mild (1-8), moderate (9-16), and severe (17-24). Furthermore, all scans were reviewed for the presence of wall thickening/sclerosis as a marker for chronic sinusitis. For comparison, we performed a retrospective review of sinus CT exams on non-WTC exposure patients imaged for persistent rhinosinusitis despite treatment during the same time period. These studies were graded in a similar fashion.

RESULTS
Of more than 1000 patients seen in the WTC clinic between 7/2005 and 6/2007, 57 underwent sinus CT exams for further evaluation. A comparable cohort of 56 patients with sinusitis who failed initial conservative treatment was randomly generated from our electronic database. The mean graded score of the WTC patients was 5.8 compared with 6.9 for the non-WTC patients (p<0.3). Furthermore, 68% of the WTC patients had mild disease versus 63% for the comparison group. In both cohorts, 5% of the patients demonstrated signs of chronic sinus infection and the maxillary sinuses were predominantly involved.

CONCLUSION
The aftermath of the WTC disaster has manifested as upper and lower respiratory disease. Our preliminary analysis demonstrates that there is no difference in the the severity of CT findings of sinus inflammatory disease in patients exposed to the WTC dust/chemicals as compared to a cohort of the general population who have failed initial medical treatment of their sinus disease. We plan to continue to follow these patients to evaluate the extent of their disease.

KEY WORDS: Sinusitis, World Trade Center

Paper 242 Starting at 4:26 PM, Ending at 4:34 PM
CT Appearance of Intraoral Foreign Bodies
McDermott, M. · Branstetter, B. F. · Escott, E. J.
University of Pittsburgh
Pittsburgh, PA

PURPOSE
Comestible intraoral foreign bodies (IOFB), such as candies, gum, and chewing tobacco, are seen incidentally on many CT scans of the head and neck. If these foreign bodies are misinterpreted as pathology, patients may be subjected to unnecessary distress or unneeded radiation from additional imaging. The purpose of this study is to characterize the CT appearance of comestible IOFBs, and to find characteristics that distinguish them from true pathology.

MATERIALS & METHODS
With IRB approval, 30 patients who already were scheduled to undergo CT examinations of the head and neck were enrolled in the study. Nine typical IOFBs with different physical characteristics were selected for inclusion. Each patient placed one IOFB in his/her mouth prior to the initiation of the routine clinical scan. The resulting scans were evaluated by two head and neck radiologists. In vivo and ex vivo density measurements were obtained for each IOFB.

RESULTS
The density of comestible IOFBs ranged from 184 to 475 Hounsfield units. Large, hard IOFBs were distinguished most easily from mucosal lesions, but might be mistaken for odontogenic tumors. Small, hard IOFBs could be mistaken for calculi, tooth fragments, or enhancing vessels. Soft IOFBs generally had more confusing configurations, and more heterogeneous densities, and thus might be mistaken for enhancing mucosal lesions. Foci of gas usually were identified within chewable IOFBs, mimicking abscess. Because all IOFBs had higher densities than soft tissue, they could all be mistaken for calcified, enhancing, or bony lesions. Examples of several true pathologies with CT appearances similar to that of IOFBs were identified.
CONCLUSION
Radiologists frequently encounter IOFBs on CT examinations of the head and neck. Familiarity with the expected appearance of these incidental pseudolesions is important to prevent misdiagnosis as true pathologic processes.

KEY WORDS: Oral cavity, foreign bodies

Paper 243 Starting at 4:34 PM, Ending at 4:42 PM
Periscalar Soft Tissue Is the Most Common MR Finding in Erb’s Palsy

Wandler, E. · Lefton, D. · Fazekas, J. · Babb, J. · Shatkes, D.
'Beth Israel Medical Center, New York, NY, 'St. Luke’s–Roosevelt Medical Center, New York, NY, 'New York University Medical Center, New York, NY

PURPOSE
To evaluate the prevalence of soft tissue lateral to the anterior scalene muscle on MR imaging of the brachial plexus in children with Erb’s palsy relative to the prevalence of the more commonly described findings of pseudomeningocele formation, posterior humeral head subluxation and spinal cord signal abnormality.

MATERIALS & METHODS
This retrospective study from two institutions consists of a sequential series of 37 subjects (mean age, 9 months; age range, 3-28 months) clinically diagnosed with Erb’s palsy from birth trauma. MR imaging examinations of the brachial plexus were performed on a 1.5 T magnet during the time period of April 1997 through July 2006 and consisted of T1 and T2 weighted sequences in the axial, sagittal and coronal planes. Each study was evaluated independently by two neuroradiologists. The presence of periscalar soft tissue on the ipsilateral side of injury was assessed; if present, the signal characteristics were recorded. Other findings noted included the presence of pseudomeningocele, posterior humeral head subluxation and spinal cord signal abnormalities. Interobserver agreement was evaluated using a simple kappa coefficient for all binary assessments. The Blyth-Still-Casella procedure was used to construct an exact 95% confidence interval (CI) for the percentage of patients seen to be positive for a specific imaging or anatomical feature by at least one of the two observers and for the percentage positive according to both of the readers.

RESULTS
The percentage of subjects found to have periscalar soft tissue by both readers was 95% (35/37) with a 95% CI of [86.2%, 99.9%]. The signal intensity was typically isointense to muscle on T1-weighted images and hyperintense to muscle on T2-weighted images. Pseudomeningocele and posterior humeral head subluxation were reported in 40% (15/37) and 81% (30/37) of subjects, respectively. No spinal cord abnormalities were observed. Kappa coefficient values were 0.654, 0.802 and 0.945 for periscalar soft tissue, humeral head subluxation and pseudomeningoceles respectively.

CONCLUSION
Periscalar soft tissue was the most common MR finding in our series of subjects with Erb’s palsy and was observed more frequently than the better known entities of pseudomeningocele formation and humeral head subluxation.

KEY WORDS: Erb’s palsy, brachial plexus

Paper 244 Starting at 4:42 PM, Ending at 4:50 PM
A New and Failsafe Method of Labeling Cross-Sectional Images for Sidedness

Mackey, J. K. · Cunnane, M. E. · Curtin, H. D.
'J. Kevin Mackey, MD, Inc., Los Angeles, CA, 'Massachusetts Eye and Ear Infirmary, Boston, MA, 'Massachusetts Eye and Ear Infirmary, Harvard University, Boston, MA

PURPOSE
To create a device that eliminates errors in labeling sidedness in cross-sectional imaging. If the technologist enters patient position parameters incorrectly, such as prone instead of supine, the computer will mislabel the images for sidedness. This does not happen often, but when it does it can be problematic for the patient and everyone else involved. A high percentage of wrong site surgeries are followed with medical malpractice lawsuits. This new device is to remove the human element so that human errors do not occur. The new device results in an “R” label in the image that cannot be manipulated by postprocessing.

MATERIALS & METHODS
A three-dimensional “R” marker is used to create a two-dimensional label of sidedness when the marker is imaged in cross section. The marker consists of a radiopaque circular rod with hollowed out central portion in the shape of the letter “R” that when imaged in cross section creates the “R” notation in the obtained image. The rod is attached to the right temple piece of a pair of eyeglass frames. The eyeglass frame has a tall bridge over the nose, so that the eyeglass frame can only be worn one way on a person. When the eyeglass frames are worn the rod will be adjacent only to the right side of the head or face. The device is similar in overall appearance to a diver wearing a facemask with snorkel attached on the right side. The rod rotates at its attachment point, so the “R” symbol may be imaged in any plane from axial to coronal. Computed tomography images of the device on a phantom were obtained.

RESULTS
Cross-sectional images acquired with the device clearly show the “R” symbol on the right side of the anatomy within the image. The “R” is identified readily, as it is immediately adjacent to the anatomy. The device’s “R” mark is easier to notice that the smaller computer generated “R” and “L” at the margins of the image. The device’s “R” cannot be changed on the computer by the technologist after the fact as it is a part of the image, not an external annotation. If the images are flipped or otherwise electronically manipulated, the device’s “R” will still be adjacent to the right side of the anatomy. If a film is viewed backwards in the operating
room, the device’s “R” mark is clearly visible adjacent to the anatomy, and the side of the pathology is readily apparent relative to the “R”.

CONCLUSION
This new method of labeling sidedness eliminates errors in labeling of cross-sectional images for sidedness and may lower the frequency of wrong site surgery.

KEY WORDS: Right, malpractice, error

Paper 245 Starting at 4:50 PM, Ending at 4:55 PM

Roof of Mouth Foreign Bodies in Children: Clinical and Imaging Findings in Three Cases
Koch, B. L.¹ · Hedlund, G. L.² · Goold, A. L.¹ · Ellaru, R. G.¹ · Shott, S. R.¹
¹Cincinnati Children’s Hospital Medical Center, Cincinnati, OH, ²Primary Children’s Hospital, Salt Lake City, UT, ³Tripler Army Medical Center, Honolulu, HI

PURPOSE
To present the clinical history and imaging findings in three children with foreign bodies adherent to the roof of the mouth.

CASE REPORT
This was a retrospective review of the clinical records and imaging findings in three toddlers who presented with intraoral hard palate masses. We present the clinical history, imaging and intraoperative findings of three children with roof of mouth foreign bodies.

IMAGING FINDINGS
In all three children, CT demonstrated well defined smooth, nonenhancing masses adherent at the roof of the mouth, without erosion of the hard palate. All contained a small amount of air that proved to be located between the foreign body and the hard palate. Intraoperative findings included a sea shell, a plastic eye from a stuffed animal and a tiddly wink disk.

SUMMARY
Primary or acquired masses of the hard palate are distinctly uncommon in young children. When a mass is identified in this location, particularly when there is air within the lesion, foreign body should be a major consideration.

KEY WORDS: Foreign body, roof of mouth

Paper 246 Starting at 4:55 PM, Ending at 5:00 PM

Association of Moyamoya Disease with Basal Transsphenoidal Meningoencephaloceles, Ocular, and Pituitary Abnormalities: A Report of 2 Cases
Khan, A. ¹ · Vartanian, S. A.¹ · Fischbein, N.² · Steinberg, G²
¹William Beaumont Hospital, Royal Oak, MI, ²Stanford University Medical Center, Palo Alto, CA

PURPOSE
The combination of basal cephaloceles and moyamoya disease is very rare. We describe 2 cases which demonstrate an association between moyamoya disease and midline cranial defects such as basal transsphenoidal meningoencephaloceles, ocular and pituitary abnormalities.

CASE REPORT
Case 1: A 2-year-old girl presented initially at 7 weeks of age with morning glory syndrome and bilateral colobomas, with subsequent MRI and MRA workup demonstrating unilateral moyamoya disease and a transsphenoidal basal meningoencephalocele. A SPECT cerebrovascular flow study after Diamox administration demonstrated impaired hemodynamic reserve in the right parietal region, although the patient was clinically asymptomatic. The patient subsequently underwent a right frontotemporal craniotomy with a microscopic extracranial-to-intracranial revascularization procedure, which improved blood flow. Case 2: A 20-year-old female with developmental delay, short stature, diabetes insipidus, and oligomenorrhea was found to have moyamoya disease as detected by MRA and MRI during workup for progressively worsening headaches. The patient also had an anterior communicating artery aneurysm, which was coiled successfully. The MRI demonstrated a large transsphenoidal basal meningoencephalocele, pituitary dysgenesis, and moyamoya-type vessels, left worse than right. The patient subsequently underwent a left frontotemporal craniotomy with a microscopic extracranial-to-intracranial revascularization procedure, which improved blood flow.

SUMMARY
Although the causal link between moyamoya disease and midline structural abnormalities is not completely known, an association in a minority of moyamoya cases does appear to exist. Knowing this association will allow for heightened awareness and improved detection for neuroradiologists when viewing cases of patients suspected of moyamoya disease.

KEY WORDS: Moyamoya, encephalocele, midline cranial defects
Tuesday Afternoon
3:30 PM – 5:00 PM
Room 211/212

(28d) SPINE: Spine Interventions, Vascular Lesions and Vertebroplasty
(Scientific Papers 247 – 257)

See also Parallel Sessions
(28a) ADULT BRAIN: Functional Imaging/MRI
(28b) PEDIATRIC: Epilepsy, Inflammatory, Infectious Diseases/Excerpta
(28c) HEAD & NECK: Pharynx, Larynx, Soft Tissue, Sinonasal & Other

Moderators: Blake A. Johnson, MD
Basem A. Georgy, MD

Paper 247 Starting at 3:30 PM, Ending at 3:38 PM
Long Axis Multidirectional Fluoroscopically Guided Sacroplasty Aided by Fluoroscopically Generated Dyna CT

Tang, L. E. · Farid, H. · Wong, W. H.
University of California San Diego
San Diego, CA

Purpose
Sacroplasty commonly is performed under CT guidance because the fracture lines are identified more clearly by CT than by fluoroscopic guidance such that short axis entry by CT is favored. Most insufficiency fractures of the sacrum occur parallel to the sacroiliac joints. Long axis cement injections have been performed entirely by fluoroscopic guidance injecting cement parallel to the sacroiliac joints. However visual identification of fracture lines by fluoroscopy alone is frequently difficult and uncertain. We proposed to perform sacroplasty by fluoroscopically-directed needle insertion aided by Dyna CT technique to verify fracture lines and to aid in needle placement in those cases that fracture identification by fluoroscopy was uncertain. Final outcomes would be assessed by cement distribution and patient outcome.

Materials & Methods
Four patients with painful sacral insufficiency fractures that were difficult to visualize by fluoroscopy alone and were refractory to conservative management were selected for long axis fluoroscopically-guided sacroplasty aided by Dyna CT. Outcomes were assessed by final fluoroscopic images of cementation and patient outcomes in terms of changes in pain (VAS) and mobility (FIM).

Results
Cementation occurred along fracture lines without adverse leakage. There were no complications. VAS scores improved from average 8/10 to 3/10. Functional independence measurement (FIM) scores improved from average 4/5 to 2/5.

Conclusion
Sacroplasty can be performed effectively in the fluoroscopic suite and for those fracture that may be difficult to visualize by fluoroscopy alone, fluoroscopically-generated Dyna CT may be helpful.

Key Words: Sacroplasty, Dyna CT, sacral fractures

Paper 248 Starting at 3:38 PM, Ending at 3:46 PM
Safety and Efficacy of Multilevel Percutaneous Vertebroplasty

Kobayashi, N. · Numaguchi, Y. · Fuwa, S. · Ishiyama, M. · Okajima, Y. · Usami, Y. · Uemura, A. · Saída, Y.
St. Luke’s International Hospital
Tokyo, JAPAN

Purpose
Percutaneous vertebroplasty (PV) has become a common procedure for treatment of painful compression fractures of the vertebral bodies. We reviewed our consecutive 520 PV sessions to evaluate both short-term safety and efficacy of multilevel (over 3 vertebral) treatments.

Materials & Methods
A total of 520 sessions of PV in 460 patients were performed at our institution from February 2002 to November 2007 and a total of 1301 spinal compression fractures were treated. Twenty percent of the sessions (102/520) involved treatment of a single level, whereas 32% (166/520) involved two levels, 28% (148/520) involved three levels, 15% (77/520) involved four levels, and 4% (23/520) involved five levels. Four sessions (0.7%) involved treatment of six levels, but there were no cases in which treatment of more than six fractures was performed in a single session. We correlated two groups for descriptive purposes; single or two levels vertebroplasty and multilevel (three or more levels) vertebroplasty. Chart review of the procedure notes, imaging studies, clinical visits, and follow-up telephone interviews were performed for each patient. Evaluation at each follow-up time point included pain response (subjective and visual analog pain score), change in mobility, change in pain medication usage, and modified Roland-Morris Disability Questionnaire score (RMS: our own version in Japanese). Significant procedure-related complications that occurred from the time of the procedure also were specifically extracted from the patients’ medical records.

Results
There was a dramatic improvement in all evaluated parameters following percutaneous vertebroplasty. The improvement in pain, mobility, medication usage, and Roland-Morris score was noticed immediately after the procedure and persisted through the 2-year follow up. There is no significant difference among two groups in VAS and RMS. Total cement volume in multilevel vertebroplasty was naturally larger than single or two level vertebroplasty but did not exceed 20 gm. There were a few case of complications such
as osteomyelitis, but postprocedural transient pyrexia and temporary reduction of PaO2 (partial pressure of oxygen in arterial blood) were common. →

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<tr>
<th></th>
<th>Single or Two Level</th>
<th>Multilevel</th>
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<td>6.6±13(5.3)</td>
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<tr>
<td>PaO2 #</td>
<td>1.9 mmHg↓</td>
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<tr>
<td>Cement Volume</td>
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<tr>
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<td>55 min</td>
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<tr>
<td>Secondary Fracture Rate</td>
<td>2.2%</td>
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#1 Difference of PaO2 in preprocedural and 30 minutes after injection of bone cement; #2. Bone mineral density (young adult mean); #3. Over 37.8 degrees C (100.0 degrees F).

CONCLUSION
According to our results, multilevel vertebroplasty is probably safe and effective procedure as well as standard single or two-level vertebroplasty for painful spinal compression fractures. However, it may be prudent to keep a total amount of cement volume under 20gm in one treatment session.

**KEY WORDS:** vertebroplasty, multilevel

**Paper 249 Starting at 3:46 PM, Ending at 3:54 PM**

**Vertebroplasty: What’s Important and What’s Not?**

Al-Ali, F. · Kocol, K. Z. · Barrow, T. · Sciamanna, M. · Major, K. · Luke, K.

¹Borgess Medical Center, Kalamazoo, MI, ²Michigan State University Kalamazoo Center for Medical Studies, Kalamazoo, MI

**PURPOSE**
This prospective study was conducted to 1) determine if vertebroplasty increases the likelihood of a subsequent fracture, 2) examine the correlation between the amount of cement used and the degree of pain relief, and 3) examine the consequences of different sites of cement extravasation.

**MATERIALS & METHODS**
Patients who had moderate to severe back pain associated with osteoporotic compression fractures or traumatic fractures of the thoracic or lumbar spine that was refractory to conventional medical therapy were included in the study. Pain intensity was assessed on a scale from 0 (no pain) to 10 (worst pain the patient had ever experienced) before vertebroplasty and at 1 day, 1 week, 1 month, and 1 year after vertebroplasty. The volume of cement injected during the vertebroplasty was recorded, and radiographs taken during the procedure were examined to determine the percentage of anterior and posterior fill and extravasation of cement into the veins, soft tissue, or disk space.

**RESULTS**
Between April 30, 2002 and April 18, 2007, 545 vertebroplasties were performed on 300 patients of mean age 76.4 years (range, 35-96 years), the majority of which were women with osteoporotic compression fractures. Of the 545 procedures, 300 were done to repair primary fractures (primarily at vertebral levels L1 and T12), and 245 were done to repair secondary fractures (primarily at vertebral levels L1 and L2). The mean procedure pain score for all fractures was 7.6 (range, 1-10). Secondary fractures occurred in 62 (21%) of the patients in a mean of 150 days (range, 3-1006 days) after the primary vertebroplasty and were adjacent to the primary fracture in 53 (18%) of the patients. Age, the volume of cement, the percentage of anterior or posterior fill, the distribution of cement (across the midline or fill of fracture line), any extravasation (veins, soft tissue, disk), extravasation inside the disk, and vertebral level of the fracture (T3-T8, T9-T12, or L1-L5) were not significant predictors of a subsequent adjacent fracture in a logistic regression model. None of these variables was significantly different between those who suffered an adjacent secondary fracture and those who did not. For all fractures, the mean volume of cement injected was 5.0 cc (range, 1.0-12.5 cc), and the mean pain improvement after vertebroplasty was -5.6. No correlation was found between cement volume and pain relief (r = 0.0447). Extravasation of cement to any area (veins, soft tissue, or disk) had no effect on pain improvement after vertebroplasty (mean pain improvement, -5.6 with or without extravasation). Likewise, extravasation of cement inside the disk had no effect on pain improvement (mean pain improvement, -5.6 with or without extravasation inside the disk).

**CONCLUSION**
The incidence of an adjacent secondary fracture after vertebroplasty (18%) is comparable to that expected for untreated vertebral compression fractures (19%). Cement volume does not correlate with pain relief. Extravasation of cement inside the disk does not increase the likelihood of a subsequent adjacent fracture and has no effect on the amount of pain relief after vertebroplasty.

**KEY WORDS:** Vertebroplasty, refracture, extravasation

**Paper 250 Starting at 3:54 PM, Ending at 4:02 PM**

**Prospective, Randomized, Single-Blind Study Comparing Cortoss and PMMA in the Treatment of Symptomatic Osteoporotic Vertebral Fractures: One Year Data**

McCollom, V. · The Cortoss Study Group

Mercy Health Center
Oklahoma City, OK

**PURPOSE**
This study compared safety and effectiveness of Cortoss and PMMA in treatment of osteoporotic vertebral compression fractures (VCF). Cortoss is a recently developed material that possesses potential advantages over PMMA. The most important are absence of monomer fumes during preparation and setting, low total amount of thermal energy that is given off during polymerization and ease of use.

**MATERIALS & METHODS**
Excluded were greater than 70% collapse, spinal canal compromise, neurologic deficits or instability at level (s) to be treated, three or more symptomatic levels and/or tumors. Included patients (pts) were symptomatic with a visual analogue pain scale (VAS) > 50/100, and an Oswestry Disability Index (ODI) score > 30% for > 4 weeks, or exhibit progres-
sive collapse of the vertebra(e). Intraoperative fluoroscopy and pre and postoperative CT were used to assess leakage. Outcomes were assessed at 72 hours, 1 week, 1, 3, 6, 12, and 24 months. Gross morphology of level(s) treated also was evaluated. For a patient to be a success, they needed 20 point improvement in VAS with absolute score below 50, exhibit no deterioration in function, have no serious device-related adverse events, no device-related surgical interventions and no change in gross morphology.

**RESULTS**

Two hundred fifty-six pts enrolled at 21 sites, 162 treated with Cortoss and 94 with PMMA. Today 178 pts completed 12 months follow up and 51 pts 24 months. Patient demographics are matched between groups. Average age was 76 years (range 33-95). Three hundred fifteen levels were treated (114 PMMA, 201 Cortoss). Fill patterns between Cortoss and PMMA differed, and the average volume for Cortoss was 2.28 cc and PMMA 3.56 cc. Leaks were seen in 68.5% of pts for Cortoss and 68.1% for PMMA. In three pts they were thought to have mild clinical consequences. Investigators, experienced in vertebroplasty using PMMA, rated the use of Cortoss (very) easy in 86% of procedures. Combined outcome success results are depicted in the figure.

**CONCLUSION**

To our knowledge, this is the first randomized prospective long-term study in VCF. Results show that in spite of comorbidities and strict criteria both materials have comparable and very high success rates in the treatment of VCF, that are maintained for 24 months. The lower volume necessary with Cortoss to achieve the clinical benefits coupled with its other characteristics offer potential benefits over PMMA. These results are consistent with results from a European prospective vertebroplasty study using Cortoss.

**KEY WORDS:** Randomized, vertebroplasty, Cortoss

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**Paper 251 Starting at 4:02 PM, Ending at 4:10 PM**

**Percutaneous Anterior Column Stabilization in Metastatic Spine Lesions: Value of Plasma-Mediated Radiofrequency Ablation and Cement Augmentation**

Georgy, B. A. 1,2

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**PURPOSE**

In surgical treatment of patients with advanced metastatic spine lesions, the primary objective of anterior stabilization surgery is to restore or preserve the integrity of the anterior 2/3 of the vertebral body. Percutaneous combined plasma-mediated radiofrequency ablation and vertebral body augmentation may offer a less invasive option for performing anterior stabilization and appears to be particularly useful for cases with cortical destruction, epidural extension or both. The purpose of this study was to evaluate bone cement deposition patterns in treated vertebral bodies using that combined approach to determine if this type of treatment may provide an acceptable alternative for performing anterior stabilization in patients treated for advanced metastatic spine lesions.

**MATERIALS & METHODS**

Patients with advanced metastatic lesions who underwent percutaneous combined plasma-mediated radiofrequency ablation and vertebral body augmentation were included in the study (n=30 with 34 levels). The procedure consisted of first creating a void in the anterior portion of the tumor-infilt rated vertebral body using a bipolar plasma radiofrequency-based wand (ArthroCare Corporation, Austin, TX) and then inserting bone cement. Computerized tomography (axial) scans collected immediately following the procedure were reviewed to qualitatively determine patterns of deposition of bone cement. All patients reported pain status before the procedure and 2-4 weeks afterwards. Study was approved by the Institutional IRB Board.

**RESULTS**

Bone cement was deposited in the anterior 2/3 of the vertebral body in 28 of 34 levels (82.3%) treated. The rest of the cases showed cement distribution all over the vertebral bodies. In nine cases, all of the bone cement was deposited in the anterior column. In 20 (58%) of the treated levels, traces of bone cement were detected outside the vertebral body; 14 were cortical and five were venous and one epidural. Cement extravasation was clinically inconsequential in all cases. Twenty-five (83%) patients reported pain relief following the procedure.

**CONCLUSION**

Plasma-mediated radiofrequency ablation allows more control over cement deposition and increased predictability for achieving success in stabilizing the anterior two thirds of the vertebral body, a pattern that adds to the stability of the involved bone and eventually can replace extensive anterior surgical stabilization techniques. Although incidence of cement leakage using this technique appears to be relatively high, they are clinically insignificant and less than the published data based on CT evaluation in malignant lesions.
REFERENCES


KEY WORDS: Vertebroplasty, cementation, neoplasm

Paper 252 Starting at 4:10 PM, Ending at 4:18 PM

Imaging of Spinal Arteriovenous Fistulae and Treatment Implications

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PURPOSE

When treatment of a spinal arteriovenous fistula (SAVF) is anticipated, precise location of the level and side of the feeding artery is necessary. Though digital subtraction angiography (DSA) is the reference standard for imaging SAVFs, noninvasive vascular imaging [multidetector computed tomographic angiography (MDCTA) and magnetic resonance angiography (MRA)] are newer imaging modalities proved to be able to demonstrate SAVF. We present our experience with these techniques, examine the accuracy of MDCTA and MRA compared to DSA and intraoperative findings and illustrate how noninvasive angiography can affect treatment.

MATERIALS & METHODS

Twenty-one consecutive patients in their seventh decade (16 male) were investigated from 2002 to 2006 suspected to harbor a SAVF. Noninvasive angiography (20 patients had CTA) identifying the site of the SAVF in 19. Operatively, the site of the SAVF was confirmed in all 11 patients with preoperative MDCTA; two out of these 11 patients had only noninvasive angiography, and in another patient DSA had failed to demonstrate the SAVF. Sixteen patients had MRA, confirming a SAVF in all cases and the correct sites in 12. In two cases two possible levels of feeders were suspected. Invasive angiography in 1 out of 17 patients, DSA failed to demonstrate the SAVF.

RESULTS

Six patients had no treatment. Endovascular treatment: Three patients were treated successfully by embolization, one with persistent neurologic deficit, probably related to the procedure; in two patients endovascular treatment failed, one of whom subsequently underwent successful surgical repair. Surgical repair: 12 patients had primary surgical repair with confirmation of the angiographic lesion. In those cases where preoperative MDCTA was performed, MDCTA volume rendered spinal reconstructions aided the peroperative localization.

CONCLUSION

Noninvasive angiography for the diagnosis of SAVF is safe and accurate, MDCTA aids peroperative localization and DSA should be reserved for patients with inconclusive noninvasive angiography or when identification of the artery of Adamkiewicz is required prior to embolization.

KEY WORDS: Spinal arteriovenous fistula, imaging, diagnosis

Paper 253 Starting at 4:18 PM, Ending at 4:23 PM

Multiorgan Arteriovenous Malformations and the Role of MR Angiography in the Characterization and Follow Up of Spinal Locations

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1.Hospitais da Universidade de Coimbra, Coimbra, PORTUGAL, 2.Hospital Garcia de Orta, Almada, PORTUGAL

PURPOSE

To propose an optimized magnetic resonance angiography (MRA) method to study spinal arteriovenous malformations (AVMs). We also show the first case of multiorgan arteriovenous malformations with a spinal location (to the best of our knowledge there is no published case with this association).

CASE REPORT

A 29-year-old female, with a spastic paraparesia presented with back pain, neurologic claudication and grade 3 force at dorsiflexion of both feet. Spinal CT, abdominal ultrasound, thoraco-abdominal CT, endoscopy and colonoscopy were performed. Fast spin-echo T1- and T2-weighted images using a 1.5 T scanner were done for spinal MR. For MRA we first used test bolus technique and then a triple dose of Gd-DTPA at a fixed rate of 2ml/s followed by a saline flush were injected. The MRA set was acquired in the sagittal plane in order to include the descending aorta and spine from dorsal region. We used a FLASH-3D sequence, with the acquisition beginning at the center of the K space, TR/TE/FA=6,2/1,9ms/35º, FOV of 384mm (vertical) x160mm (anteroposterior); 80 sagittal partitions with 1mm; matrix of 384x136, Partial Fourier: 85%(phase), 75%(partition). Acquisition time was 40s. Images were postprocessed on a dedicated workstation (ADW 4.4 GE Healthcare) with multplanar reformats and 3D reconstructions. Finally brain MRI and spinal DSA were performed.

IMAGING FINDINGS

The spinal CT showed an intracanalar expansive lesion at the level of L1. The hypothesis of a neoplastic lesion was considered. An abdominal ultrasound was performed which demonstrated multiple hepatic nodules. Endoscopy and colonoscopy showed no primary gastrointestinal tumor. Thoraco-abdominal CT showed cardiomegaly, a lobar pulmonary AVM and confirmed the presence of hepatic nodules. Subsequent abdominal MR revealed imaging findings consistent with multiple focal nodular hyperplasia (FNH). MR angiography showed a spinal AVM at the level of L2 as shown in the figure. These findings were confirmed by DSA. The brain MRI showed no space occupying or vascular lesions.
SUMMARY
From an initial suspicion of a disseminated tumor, we found multiple vascular malformations integrated in the context of a multiple FNH syndrome. On the other hand, although DSA is still the gold standard, this case is an example that, with further optimization of MRA sequences in the future, this technique might replace DSA for the pretherapeutic characterization of spinal AVMs.

KEY WORDS: Spinal arteriovenous malformations, MR Angiography, multiorganic arteriovenous malformations

Paper 254 Starting at 4:23 PM, Ending at 4:31 PM
Does the Injectate Reach the Disk Pathology in Cervical Interlaminar Epidural Steroid Injections?

Safriel, Y. · Kubal, W.
1Yale University School of Medicine, Yale, CT, 2Radiology Associates of Clearwater, Clearwater, FL, 3Pharmascan Clinical Trials, Largo, FL

PURPOSE
Cervical interlaminar epidural injections usually are performed at C7-T1 or, in rare cases, at C6-7. This is due to the upper cervical epidural space being too small to accommodate a needle and the subsequent danger of intrathecal injection. Cervical interlaminar injections at C7-T1 have been performed routinely for many years as an effective means of palliating neck pain. However, to date, there has not been a study to confirm that the injectate is reaching pain generators in the mid and upper cervical spine.

MATERIALS & METHODS
We reviewed our data retrospectively between April and October 2007 for patients who had a cervical interlaminar image-guided epidural injection at C7-T1 with epidurography (PA and oblique) postprocedure and an antecedent MRI. Fluoroscopic snap shot images were obtained at the time of needle entry into the epidural space and immediately after needle removal at the conclusion of the study. MR imaging consisted of sagittal T1 and T2 images as well as axial T2 and gradient images. The procedural notes including amounts injected also were reviewed. The epidurograms (including injectate volumes) and antecedent MR images then were reviewed side by side.

RESULTS
Twenty cases were identified that had all the relevant data available for review. All 20 cases had interlaminar epidural steroid injections using a 22 gauge, 3.5 inch Whitacre needle via a left oblique interlaminar approach. Each procedure consisted of a 5 cc contrast injection of Isovue-200 (Bracco Diagnostics, Princeton, NJ) and 2 cc of Celeston Soluspan 6 mg/ml (Betamethasone, Schering AG, Germany). The procedures were performed by an experienced neuroradiologist with training in interventional pain procedures. Fluoroscopic guidance (Philips Integris, Phillips Medical Systems Seattle, WA or OEM 9600/9800, GE Medical Systems, Milwaukee, WI) was used for all procedures. All patients were discharged after 15 minutes without complications. Epidurography showed injectate extending up to the base of skull and down to T4-5 at its maximal extent, and between C6-7 and T2 at its minimal extent. On average, the injectate spread over 5.5 vertebral bodies (i.e., between C4-5 and T3). In cases where the injectate did not reach the upper cervical spine/craniovertebral junction, MRI showed that the injectate was blocked at the lowest level where there was disk pathology resulting in cord contact and moderate central stenosis (defined as minimal or no CSF surrounding the cord).

CONCLUSION
Cervical interlaminar steroid injections performed at C7-T1 are effective in delivering injectate to multiple disks throughout the cervical spine. The injectate will spread as far as the craniovertebral junction or up to the lowest level where there is cord contact due to disk pathology and moderate central stenosis.

KEY WORDS: Epidural injection, cervical, spine

Paper 255 Starting at 4:31 PM, Ending at 4:39 PM
Improved Specimen Yield during Disk Aspiration Biopsy in Patients with Suspected Spine Infection

Wattamwar, A. · Ortiz, A. O.
Winthrop University Hospital
Mineola, NY

PURPOSE
To evaluate the utility of a percutaneous diskec tomy device in the assessment of infectious spondylitis.
MATERIALS & METHODS
Nine consecutive patients underwent imaging-guided percutaneous biopsy during their clinical evaluation for suspected spine infection. Five patients were male and four were female. All patients were adults with a mean age of 67 years. Four patients already were receiving antibiotic therapy at the time of their biopsy procedure. Fluoroscopic guidance was used in eight patients and CT guidance was used in one patient. All procedures were performed by an experienced interventional neuroradiologist using coaxial technique, local lidocaine anesthesia at the puncture site, and intravenous sedation and analgesia. A posterior, lateral and oblique extradural approach was used with the patient in the prone position. An initial aspiration attempt was made using a 20 gauge spinal needle. A subsequent attempt at aspiration was made using a 17 gauge guide needle. A percutaneous diskectomy device then was inserted through the 17 gauge needle. At least two specimens (average three specimens) were obtained during each procedure. A bone biopsy of the end plate also was obtained with a bone biopsy needle. All specimens were submitted for microbiologic and pathologic analysis.

RESULTS
A significantly greater yield of specimen was observed when using the percutaneous diskectomy device in all nine patients. In seven out of the nine patients, the diskectomy device yielded a specimen when needle aspiration did not. Three patients had biopsies that were positive for infection. No procedure-related complications occurred.

CONCLUSION
A percutaneous diskectomy device can reliably obtain an adequate specimen when needle aspiration fails or is limited in patients with suspected spine infection.

KEY WORDS: Biopsy, diskitis, aspiration

Paper 256 Starting at 4:39 PM, Ending at 4:44 PM
Efficacy of Percutaneous Minimally Invasive Image-Guided Interventions in the Treatment of Life-Threatening Spontaneous Intracranial Hypotension

Aghaei Lasboo, A. · Shaibani, A. · Surdell, D. · Song, J. · Rosenow, J. · Walker, M. T.
Northwestern University
Chicago, IL

PURPOSE
To report on the efficacy of percutaneous minimally invasive image-guided interventions including epidural blood patch (EBP), percutaneous fibrin glue patch and intrathecal saline infusion in the treatment of life-threatening spontaneous intracranial hypotension (SIH).

CASE REPORT
We present a case of SIH with progressive neurologic deterioration with nearly fatal consequences who was treated with percutaneous techniques.

IMAGING FINDINGS
A 46-year-old man presented with a 4-month history of orthostatic headaches unresponsive to conservative treatment and associated with nausea and vomiting. At presenta-
Factors Associated with Traumatic Fluoroscopy-Guided Lumbar Puncture: A Retrospective Review

Johnson, A. J. · Yu, S. · Chen, M. Y. M.

Purpose

Fluoroscopy-guided lumbar puncture (LP) is a commonly requested radiologic procedure. There are a variety of reasons for obtaining a cerebral spinal fluid (CSF) sample, but for the purpose of excluding subarachnoid hemorrhage or in the setting of initial work up of malignancy, an ideal CSF specimen would be free from traumatically introduced red blood cells. The purpose of this research is to determine if factors such as patient age, gender, gauge of the lumbar puncture needle, and level of lumbar spinal puncture are associated with increased risk of traumatic fluoroscopy guided LP.

Materials & Methods

Institutional IRB approval was obtained. Data were collected retrospectively for consecutive male and female patients of all ages who had a fluoroscopy-guided LP between January 1, 2005 and December 31, 2006 at our university, children’s, private and county hospitals. Patients who had LP without fluoroscopy were excluded. There were a total of 756 fluoroscopy-guided LPs performed which met the inclusion criteria. Data were analyzed using Chi square test, Fisher’s exact test, ANOVA, and multivariate logistic regression.

Results

We used CSF red blood cell (RBC) count between 500 and 5000 cells/ml in the final tube as indicative of a traumatic lumbar puncture. There was an overall 8.2% frequency of traumatic fluoroscopy-guided LP. Subgrouping patients by age, we found that pediatric patients <12 years had failed LP rate of 26.8% compared with teenager/adult rate of 2.9%; odds ratio 12.1 (95% CI, 5.4-27.4). Infants ≤ 1 year had failed rate of 56.3%; compared with teenager/adult rates, odds ratio 42.4 (95% CI, 14.4-124.8). Both univariate and multivariate analyses were performed with factors of age, gender, needle gauge, and level of lumbar spinal puncture, yielding no statistically significant association of any factor with increased risk of traumatic fluoroscopy-guided LP. Overall rate of positive findings (RBC count > 500 or xanthochromia or increased white blood cell count) on CSF analysis was 23.7%.

Conclusion

Univariate and multivariate analyses revealed no statistically significant association of increased risk of traumatic fluoroscopy-guided LP with patient age, gender, needle gauge, or level of lumbar spinal puncture. At 8.2%, traumatic lumbar puncture rate in this study was less than reported rates for nonfluoroscopy-guided LP. On subgroup analysis, there was increased risk of failure of the procedure in pediatric patients < 12 years of age, with especially increased risk in patients ≤ 1 year of age.

References


Key Words: Lumbar puncture, trauma, efficacy

Tuesday Afternoon

3:30 PM - 4:30 PM
Room 204/205

(29) ELC Lecture B: PACS and RIS 2008: An Update

(258) — C. Douglas Phillips, MD, FACR
(259) — Richard H. Wiggins, III, MD

PACS and RIS 2008: An Update

C. Douglas Phillips, MD, FACR

PACS and RIS 2008: An Update

Richard H. Wiggins, III, MD
Challenges in Imaging the Post-Treatment Head and Neck Oncology Patient

Lawrence E. Ginsberg, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review the indications and rationale for various forms of therapy in Head and Neck Cancer.
2) Describe the expected post-treatment imaging findings.
3) Differentiate successful vs. unsuccessful therapy.
4) Review the imaging diagnosis of the complications that can result from H&N cancer therapy.

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 reliably be associated 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 pretreatment 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 are currently seeing 50-55 new head and neck malignan-
cies 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.

Pitfalls in Sinonasal Imaging
Edward E. Kassel, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Recognize imaging signs that help distinguish benign from malignant mass lesions.
2) Discuss those benign entities that may be mistaken for malignant tumors, particularly on MRI.
3) Discuss the strengths/weaknesses of CT/MRI in the diagnosis of sinonasal mass lesions.
4) Detect and avoid the diagnostic pitfalls in sinonasal imaging.

PRESENTATION SUMMARY
Sinonasal diseases of diverse etiologies must be differentiated from each other as well as from pathologies arising within adjacent facial bones, skull base, or intracranial tissues, in a clinical setting commonly associated with nonspecific signs and symptoms. For imaging of sinonasal malignancies, extent of disease is more important than offering a specific tissue diagnosis, with tissue specimen reserved for that purpose. In our eagerness to offer more exact diagnoses, especially with a focus on malignancy, we sometimes miss clues that may steer our thoughts along a different path. Imaging challenges are accentuated by the practicalities that some benign entities appear aggressive (misinterpreted as malignant) while some malignant lesions appear less aggressive (misinterpreted as benign). Understanding the strengths and weaknesses of CT/MRI in the assessment of sinonasal lesions leads to more appropriate imaging algorithms. Proper studies (extent, FOV and the necessary planes) avoid diagnostic assumptions, are able to assess whether the imaged lesion arises within or external to the sinonasal cavity or may benefit from a complementary imaging study. We tend to be very aware of the strengths of MRI for imaging sinonasal masses and less appreciative of its limitations. Some inflammatory foci may produce MR signal simulating aerated sinuses. A confusing MR appearance may be complemented by CT with its ability to assess cortical bone (or the lack of it), calcifications, dense bone, hyperostosis, fibro-osseous lesions or dental structures. When MR imaged sinonasal masses appear more complex, consider whether the lesion may be a non-neoplastic (benign) entity for which CT may be very complementary and help increase the diagnostic accuracy, for diffuse sinonasal polyposis, mucocele, fibro-osseous lesion (FOL), fungal-granulomatous (Wegener’s/sarcoid, tuberculosis) inflammatory disease, or dental mass lesions. Osteoradionecrosis may be missed on MRI but suggested on CT by the pattern of involvement of the cortical bone of the sinuses or adjacent skull base. Meningoencephaloceles may resemble a mass lesion, mucocele or mucosal polypl within the sinonasal cavity. Intact peripheral sinus mucosa suggests an infl. process. Complex heterogenous internal architecture is more typical of benign entities, eg. the prominent stranding of diffuse polyposis. Within the central skull base, pressure erosion occurs with reduced capacity for reactive bone deposition, offering a more aggressive appearance by some benign entities. Knowledge of surgical procedures, eg maxillary ridge augmentation, avoids confusion with sinus pathology.

RECOMMENDED READING

Tuesday Afternoon
3:30 PM - 5:00 PM
Room 208/209

(32) Advanced Imaging Seminar - fMRI and MEG

(263) Clinical MEG
— Erin Simon Schwartz, MD

(264) Advanced MEG Methods
— Timothy P. L. Roberts, PhD

(265) Functional Connectivity
— Bharat Biswal, PhD

Moderators: Timothy P. L. Roberts, PhD
Howard A. Rowley, MD

Clinical MEG
Erin Simon Schwartz, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Demonstrate the clinical value of MEG.
2) Discuss the process of MEG data collection.

PRESENTATION SUMMARY
Magnetoencephalography (MEG) is increasingly being used in the pre-operative evaluation of patients with a variety of neurologic conditions, including epilepsy, brain tumors, and
vascular malformations. For the patient with epilepsy, the ability to non-invasively localize ictal onset zones and their relationships to eloquent functional cortex allows the pediatric epilepsy team to more accurately assess the likelihood of postoperative seizure freedom, while more precisely prognosticating the potential functional deficits that may be expected from resective surgery. Confirmation of clinically suspected multifocality may result in recommendation against resective surgery, as the probability of seizure freedom will be low. For patient with brain tumors or vascular malformations, accurate determination of the relationship of the lesion with eloquent regions provides vital information for the neurosurgeon. Current paradigms for motor and somatosensory testing are robust. Paradigms allowing localization of those regions necessary for competent language function, although promising, are under continuous optimization.

Advanced MEG Methods
Timothy P. L. Roberts, PhD

Dr. Roberts obtained his PhD from Cambridge University, England in 1992. He undertook a post-doctoral fellowship in the field of diffusion and perfusion MRI in the Department of Radiology at UCSF with Mike Moseley and John Kucharczyk. He has subsequently been on the faculty at UCSF, where he established the Biomagnetic Imaging Laboratory, 1993) and the University of Toronto and is presently holder of the Oberkircher Family Chair in Pediatric Radiology and Vice-Chair for Research in the Department of Radiology at Children’s Hospital of Philadelphia as well as Professor Radiology, University of Pennsylvania. His work in 4D functional imaging using biomagnetic recording, specifically in the study of auditory processing and language has been supported by the National Alliance for Autism Research and is presently supported by Autism Speaks, the Nancy Lurie Marks Family Foundation, the Commonwealth of Pennsylvania and NIH. He has published in excess of 200 scientific papers, mostly in the field of physiologic and functional imaging, reviews grant proposals for NIH and several equivalent international agencies, and serves on the executive committee of the American Society for Neuroradiology, the American Society for Functional Neuroradiology and the International Society for the Advancement of Clinical MEG.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Identify the roles of high temporal resolution recording with MEG.
2) Review the utility of measuring brain electrical activity in specific frequency bands.
3) Recognize the potential application of temporal (or spectro-spatio-temporal) resolution in understanding and characterizing non-lesional neuropsychiatric disorders.

PRESENTATION SUMMARY
While the clinical implementation of MEG focuses on the twin roles of 1) identifying the source of abnormal epileptiform electrical activity and 2) mapping eloquent cortex preoperatively, these roles address only the spatial localization information available from the magnetoencephalogram. In fact inherent to this technique is also high temporal resolution (<1ms). As such it is possible to:
  i) track propagating neural activity, post stimulation or during cognitive tasks, as networks of functional cortex become active
  ii) identify intrinsic temporal signatures of stimulus feature encoding, perception and processing, via subtle latency shifts in evoked response components
  iii) capture and localize normal and pathological endogenous rhythmic activity (e.g. in delta, alpha or gamma bands), either phase locked to a stimulus (evoked rhythm), non-phase-locked (induced rhythm) or spontaneous

In outline, the presentation will cover aspects of MEG recording hardware, software and post-processing steps required to identify, localize and characterize brain activity with special emphasis on temporal resolution. Both spontaneous (interictal discharges, endogenous rhythms) and evoked (task-related) activities will be discussed as well as methods for integrating these data, along with structural MRI and DTI. Applications will be illustrated in unfolding the neural dynamics of complex processes such as word reading, as well as examining the correlates of directing attention and auditory processing. Opportunities for 5-dimensional spectro-spatio-temporal functional imaging will be introduced. Clinical application of advanced MEG methods will be addressed in terms of more specific mapping of eloquent cortex networks, as well as introducing methodological inroads pertinent to neuropsychiatric disorders such as autism spectrum disorders.
Wednesday Morning

7:40 AM – 8:40 AM
La Louisiane Ballroom

(34) Maintenance of Certification (MOC) – Adult Brain and Pediatric Spine Review
Audience Response Plus (AR+)*

(267) Adult Brain
— Jonathan H. Burdette, MD

(268) Pediatric Spine
— Andrea Rossi, MD

Moderator: Jonathan H. Burdette, MD

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

Adult Brain
Jonathan H. Burdette, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss arterial spin labeled MR perfusion imaging.
2) Recognize MR perfusion patterns in various brain pathologies.
3) Illustrate typical adult brain diagnostic dilemmas.

Pediatric Spine
Andrea Rossi, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss imaging appearances and differential diagnoses of common and uncommon spinal diseases in children.

PRESENTATION SUMMARY
This activity comprises a case-based review presentation of common and uncommon disorders involving the pediatric spine with a focus on the approach to differential diagnosis. Covered topics include causes of cauda equina root enhancement, tumoral and nontumoral conditions involving bone and epidural spaces, spinal dysraphisms, and disseminated low-grade gliomas of the spinal cord.

Wednesday Morning

8:40 AM – 8:50 AM
La Louisiane Ballroom

Memoriam: J. Arliss Pollock, MD:
Visionary, Leader, and Humanitarian

Moderator: David J. Seidenwurm, MD
Pay for Performance
David J. Seidenwurm, MD

David Seidenwurm was raised in New York City, and attended Stanford University and the Harvard Medical School. He completed his residency at Stanford, fellowship at NYU and was an assistant professor at UCSF in neuroradiology before moving to private practice. He has been with Radiological Associates of Sacramento for 17 years and currently serves as Chairman of the Diagnostic Division. He has represented Neuroradiology in various positions related to utilization and Appropriateness, performance measure development and metrics. He has been Associate Editor of Radiology and a member of the editorial board of Diagnostic Imaging. His writing has appeared in medical and popular publications from AJNR and Radiology to JAMA, and form National Review to the New Yorker. He is married and has two teenaged daughters.

Presentation Summary
Pay for performance in medicine is based on the principle, widely applied throughout our society, that people will perform better if paid to do so. While many philosophical and practical objections may exist, the trend is in the direction of more performance based reimbursement systems. The remaining questions seem to be how and to what extent, rather than whether or when. Designing relevant performance measures is challenging. Potentially useful measures must address documented gaps in care, deviations of practice from guidelines and standards based upon high quality data. Measures must be easy to understand and implement, success must be feasible and the measured variable must be under the physicians control. In addition the burden of implementation must not fall on patients through adverse selection, nor to physician through undue costs. In practice, successful performance measure development involves a collaborative process in which multiple stakeholders of differing perspectives are represented. The evidence for improvement of health care through pay for performance is comparable to the evidence that supports much of what neuroradiologist do daily.

Practice Improvement - PQRI
Michael J. Pentecost, MD

After training at USC, Dr. Pentecost was in private and academic practice in Southern California from 1980-1992. From 1992-1996, he was the chief of interventional radiology and vice-chair of radiology at the University of Pennsylvania. At Penn, he was a senior fellow in the Leonard Davis Institute of Health Economics, a collaboration of the School of Medicine and the Wharton School. In 1996, Dr. Pentecost was named professor and chairman of radiology at Georgetown University in Washington, D.C. Since April 2005, he has been the director of the Mid-Atlantic Permanente Medical Group radiology practice, the division of Kaiser Permanente in Maryland, Virginia and the District of Columbia. Dr. Pentecost has served as president of the Society of Interventional Radiology and the Society for Health Services Research in Radiology. He is the editor of the radiology textbook Abrams’ Angiography, Interventional Radiology. Dr. Pentecost was on the Board of Chancellors of the ACR from 1997-2003 and is a member of the editorial board of the Journal of the American College of Radiology.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review history, rationale, mechanisms and current status of pay-for-performance programs.
2) Discuss about the positive and negative results in published reports that have been critically evaluated.
3) Review future performance improvement strategies of Medicare and private health plans.

**Presentation Summary**

In 2005, faced with compelling evidence of uneven utilization and quality, the federal government, increasingly interested in the concept of value-based purchasing, formalized their plans in the creation of the Physician Quality Reporting Initiative (PQRI). PQRI, joining a number of other privately-conceived measures known generally as pay-for-performance programs, was applied to Medicare patients and, by 2008, has evolved into a 1.5% bonus for physicians meeting a variety of 119 guidelines. At their heart, the nearly 150 current pay-for-performance (P4P) initiatives, which involve Medicare, Medicaid and private insurers, seek to change physician behavior (i.e., improve quality) by providing incentives (i.e., money). In early programs, Beneficial results have been reported, most notably the Premier trial in which improved quality performance was recognized in Medicare patients with acute myocardial infarction, congestive heart failure, coronary artery bypass graft, community-acquired pneumonia, and knee and hip replacement. Skeptics have argued that such trials were poorly designed, fleeting in benefit and subject to confounding variables and the Hawthorne effect. Recently, in addition to quality metrics, Medicare has focused on efficiency measures, raising concerns among physicians about tradeoffs between quality and costs. Nonetheless, P4P initiatives have gained popularity and recognition with estimates that 20-30% of federal provider payments could one day be based on these strategies.

**References**

Future Directions — Moving Toward Solutions to Image Overload through an Understanding of Visual Perception and Cognition

Evan K. Fram, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss the image overload problem in medical imaging.
2) Describe some aspects of visual perception and cognition relevant to image interpretation and image overload.
3) Review some early progress that has been made in moving toward solutions to the image overload problem and the potential for further progress.

PRESENTATION SUMMARY
Too many images and too few eyes. The image overload problem is one of the biggest challenges facing radiology and the result of a perfect storm of developments: 1) The number of images per exam has exploded, the result of technical advances in scanner technology; 2) State-of-the-art PACS systems now can manage exams consisting of thousands of images, something that was impractical in the era of film; 3) The number of exams per year continues to grow as medical imaging continues to prove its value, new applications are developed, and the demand for medical care grows and 4) There is a shortage of radiologists. Innovation created the problem and innovation has the potential to fix it. But, the kinds of largely silicon-based engineering advances that enabled the explosion in image volume may be different than biologically based innovations that have the potential to move us toward solutions. While there is the hope that advances in technology will offer solutions, technical solutions to date have been limited. Despite decades of work on Computer-Aided Diagnosis, CAD has had only limited impact in radiology and virtually no impact in neuroradiology. While advanced visualization techniques such as 3D are useful, their utility is limited to only a fraction of the exams we interpret. With PACS systems capable of displaying images at rates that exceed a human’s ability to assimilate and interpret the data, the human is now the bottleneck. With man as the weak link, perception and cognition have the potential to play a central role in developing new methods for interacting with information that improve accuracy and efficiency. As a neuroradiologist interpreting an exam, we convert an exam that might consist of a billion bytes of raw digital data into clinically useful information that might be represented by a few bytes, such as “acute hematoma”. That process is based on human perception and cognition, areas that have not been well studied in the context of image overload. Today, and for the foreseeable future, the most powerful image analysis system that exists is the human, but like any system it has strengths and limitations. By improving our understanding of perception and cognition we may be able to design new ways of interacting with data that leverage the strengths and overcome the weaknesses of human perception and cognition. The challenge to developing biologically based solutions to the image overload problem is that this endeavor does not fall into a single field, but at the intersection of fields - medical imaging, visual perception, cognition, imaging informatics, and surprisingly, computer gaming. It is likely that the research and development needed to make serious advances will need to be driven by radiologists, as they understand the tasks, challenges and types of solutions needed. The goals of this talk are to: 1) Outline the nature of the data overload problem. 2) Describe features of human visual perception and cognition relevant to what we do as radiologists and to the image overload problem and 3) Review some progress that has been made with respect to the image overload problem and discuss the potential for future progress.
Imaging Myelopathy: Basic Findings & Lesion Patterns

Cesare Colosimo, MD

Dr. Colosimo was born in Rome, Italy, graduated from State University “La Sapienza” of Rome, and earned his Radiology Specialty at the Catholic University in Rome (Italy). Since 1980 his scientific interest was devoted entirely to neuroradiology, working at “A.Gemelli” Catholic University Hospital and Medical School. He directed the Neuroradiology department at University Hospital and Institute of Advanced Biomedical Technology in Chieti, Italy. Since 2005 he is full Professor of Radiology at the Catholic University of Rome, and Chief of Neuroradiology of the “A.Gemelli” Hospital and Medical School. He is a member of the Italian Association of Neuroradiology and currently he is President of the Neuroradiology Section of the Italian Society of Medical Radiology. He has authored or coauthored more than 300 scientific papers, book chapters, invited publications and abstracts. Dr. Colosimo’s main teaching focus has been directed toward basic semeiotics in neuroradiology, especially regarding focal brain lesions and differential diagnosis of brain and spinal cord tumors.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Define key MRI findings of myelopathies.
2) Recognize the basic spinal cord lesion patterns in order to address the differential diagnosis of intrinsic myelopathies.
3) Categorize MRI appearance of “extrinsic” myelopathies.

PRESENTATION SUMMARY
The continuous improvement in contrast/spatial resolution of the magnetic resonance imaging (MRI) of the spinal cord (SC) has allowed significant progresses in the diagnosis of myelopathies, mainly in terms of increased sensitivity. Despite these advances, MRI specificity in SC diseases is relatively low, and the differential diagnosis of SC diseases remains problematic: uncertain diagnoses may result in delayed and/or inappropriate treatment. Thus it is of utmost importance to develop an effective algorithm to analyze MRI findings and to design “a step-by-step” diagnostic process to address the differential diagnosis in patients with myelopathy. The presentation will move from the normal MRI appearance of the SC across different pulse sequences, through the key imaging findings to be considered, such as number, location and longitudinal extent of the abnormalities, their topography in the axial plane, their symmetry, shape and margins, and the resulting effect on the spinal cord size/diameters. Attention will be posed on the involvement of gray versus white matter and of meningeal surfaces and nerve roots. Finally, special interest will be directed to signal pattern recognition, mainly based on T2-weighted and post-contrast T1-weighted imaging. Following the suggested “step-by-step” diagnostic process will guide toward a lesion pattern recognition that, taking into account the necessary clinical data, consequently will lead to narrow the differential diagnosis.

Advanced Imaging of the Spine

Eric D. Schwartz, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Review cutting-edge imaging techniques for evaluating the spine.
2) Review strategies to implement advanced imaging in the clinical setting.
3) Discuss the basic histologic correlation for the advanced imaging techniques.

PRESENTATION SUMMARY
In this lecture, we will review cutting edge techniques for imaging diseases of the spinal cord, both experimentally and clinically. Modalities to be presented include diffusion tensor imaging (DTI), functional MRI (fMRI), magnetic resonance spectroscopy (MRS). Most of these techniques have been used to evaluate the spinal cord parenchyma, and we will look at inflammatory, vascular, traumatic and neoplastic conditions. We will review the histologic information these techniques have shown in the experimental setting. Implementation of these sequences to the clinical setting can be difficult and we will look at some strategies designed to overcome issues such as spinal cord motion and the small size of the spinal cord.

REFERENCES
Optimizing High Field Spine Imaging

Meng Law, MD

Learning Objectives

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

1) Cite the Factors Affecting Image Quality for Spine Imaging at 3T.
2) Review the Artifacts at High Field.
3) Discuss how to reduce these artifacts and the Synergistic Effect of Parallel Imaging.
4) Optimize Sequence Choice/Parameters, e.g. T1 FLAIR vs TSE/FSE at 3T.

Presentation Summary

Image quality in spine MR imaging is dependent on five major factors:

- Spatial Resolution
- Contrast to Noise (CNR)
- Signal to Noise (SNR)
- Temporal Resolution
- Artifacts

At 1.5 T, MR imaging of the spine has evolved so that sequences and sequence parameters have been improved over many years to optimize each of these factors. However, going to higher magnetic field strength (BO) will affect each of these components individually and also in an interrelated fashion. In general, at 3 T, one can obtain improvements in spatial resolution, SNR, temporal resolution at a cost of reduced CNR (T1-weighted imaging) and increased artifacts. Increased SNR also can be used to improve spatial and temporal resolution, thereby improving image quality, decrease artifacts and patient throughput.

Spatial Resolution: At 3T, the slice thickness and effective voxel size can be reduced to improve spatial resolution. The improved spatial resolution at 3T should theoretically allow visualization of nerve roots, MS plaques, subtle cord pathology, annular tears, differentiation between gray and white matter. In general, matrix sizes can be improved from 256 x 256 to 512 x 512 and then further to 1024 x 1024 with parallel imaging. Similarly, section thickness can be reduced from 5 mm to 3 mm even to 1 mm slice thickness to achieve 1 mm isotropic voxels.

Signal to Noise (SNR): SNR is affected by the field strength, number of excitations, larger voxel sizes and shorter bandwidth. At higher BO, the higher SNR can be utilized as currency and be traded to reduce the number of excitations (reducing scan times and motion artifacts), reduce the voxel size to increase spatial resolution and/or increase the bandwidth to reduce chemical shift artifact.

Contrast to Noise (CNR): The prolongation of T1 relaxation times at higher BO results in reduced contrast (on standard T1-weighted spin-echo sequences) between structures in the spine which already have a close proximity due to the small size of structures within the spine. The increased T1 relaxation times necessitates increases in the TR to maintain T1 contrast; however this comes at a cost of increasing imaging times and increase motion and other related artifacts. Most centers have adopted T1-weighted IR sequences at 3T for brain and spine imaging. However, there have been some reports of the inability to delineate the cord from the CSF with 3T T1-weighted IR sequences. This can be overcome by the calculation of the most optimal inversion recovery time for T1 weighted IR imaging at 3T. This, in combination with parallel imaging, improves contrast significantly, and has substantially improved image quality for T1-weighted imaging of the spine at 3T.

Artifacts

- Susceptibility artifact and geometric distortion
- Chemical shift artifact-from the existence of multiple resonance frequencies
- CSF partial volume effects
- Truncation artifact - insufficient phase-encoding sampling
- B0- inhomogeneity of surrounding neck/airway structures
- Physiologic motion
- Nonphysiologic motion - gross neck motion
- Dielectric artifact
- Increased specific absorption rate (SAR)

Most of these artifacts are in part dependent of magnetic field strength. There is substantial susceptibility and signal loss in the spine from signal dephasing at the tissue-bone and tissue-air interfaces. Similarly, increasing the TE to increase T2-weighting for the cord, will result in increased CSF signal dephasing from pulsatile motion. These susceptibility effects can be decreased by using thinner sections as well as using multiple receiver coils with parallel imaging techniques. Combining phase array coil technology with higher field strengths can have a beneficial effect on other artifacts such as the dielectric effect and reducing the SAR. Modifying the shape of the RF pulse using a Variable Rate Selective Excitation (VERSE) pulse also will reduce SAR and improve image quality.
Computational Aneurysm Flow Models: Techniques and Clinical Use

Christopher M. Putman, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Discuss the techniques used for computational fluid mechanics.
2) Discuss the major flow structures in cerebral aneurysms.
3) Cite the major theories on aneurysm growth and rupture.

Presentation Summary
This lecture will review the basic principles and techniques of computational fluid dynamics used to study cerebral aneurysms. Building on this, recent theories and controversies regarding the mechanisms of cerebral aneurysm formation, growth and rupture will be examined. Finally, a discussion of the implications of these theories on our clinical decision-making will be made using representative clinical cases.

Stent Assisted Aneurysm Coiling: Pretreatment Planning

Michael J. Alexander, MD, FACS

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Analyze the anatomical factors which guide which aneurysms benefit from stent assistance during endovascular coiling.
2) Review the proper pretreatment and peri-procedural medical therapy.
3) Discuss the benefits and deficits of open and closed cell stent designs.

Presentation Summary
In the past, wide-neck cerebral aneurysms have been difficult to coil with endovascular therapy due to the high risk of coil herniation into the parent artery. Additionally, recurrence rates in wide-neck aneurysms have been much higher post-coiling than standard aneurysms. The development of stent assistance in aneurysm coiling has allowed the treatment of much more complex, wide-neck aneurysms than previously possible. This presentation will analyze the anatomical factors which guide our pretreatment stent planning, review the proper medical therapy for these procedures, and discuss some of the technical factors of stent design for these cases.

Treatment Follow Up

Kristine Blackham, MD

Dr. Blackham is an interventional neuroradiologist at the University Hospitals of Cleveland, Case Western Reserve University, Cleveland, OH. Her education is as follows: BS degree from Cleveland State University; MD degree from Case Western Reserve University; Residency at the University Hospitals of Cleveland in Diagnostic Radiology; Fellowship at the University Hospitals of Cleveland in Interventional Neuroradiology. Dr. Blackham was certified by the American Board of Radiology in June 2004 and received Subspecialty Certification in Neuroradiology in November 2006. Her interests include acute stroke imaging and endovascular treatment as well as endovascular neurointervention. Dr. Blackham has contributed to articles in several peer-reviewed publications as well as several book chapters.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review CTA and MRA techniques for the follow up of coiled aneurysms.
2) Identify aneurysm recurrence on CTA and MRA.
3) Compare CTA and MRA of coiled aneurysms with catheter based angiography.
Molecular and Biomarker Imaging in Neuroscience

J. James Frost, MD, PhD

Presentation Summary
Molecular and biomarker imaging in neuroscience represent two sides of a coin that focuses on understanding the molecular basis of brain disorders and new medication development. The differences in the two approaches is, however, diminishing as the goals of academia and industry are being rapidly consolidated within personalized medicine. The emergence of new diagnostic imaging agents is an outgrowth of this process, as new radiopharmaceuticals become increasingly important for molecular diagnosis and treatment stratification. Neurodegenerative brain disorders, including Parkinson and Alzheimer disease, already are amenable to molecular imaging techniques, but the molecular basis of mental disorders, including substance abuse, alcohol dependence, depression, and eating and obesity disorders, is less well understood. Finally, the placebo effect and its relationship to the endogenous opioid system has become better understood in recent years through the use of molecular brain imaging, with potential new applicability to medication trials.

High Field MR Imaging of Cellular Probes as Therapeutic Vehicles for the Treatment of Brain Tumors: The Next Frontier

Syed Arbab Ali, MD, PhD

Currently I have been working as Associate Scientist in the Department of Radiology, Henry Ford Hospital, Detroit, MI. I graduated from a Medical School (Institute of Post-Graduate Medicine and Research, Bangladesh) in 1988. I went to Japan in 1992 and completed PhD in Radiological Science from Yamanashi Medical University, Japan in 1998. I received training both in nuclear medicine and radiology, and worked as faculty in the Institute of Nuclear Medicine, Bangladesh and in the Department of Radiology, Yamanashi Medical University, Japan. I joined NIH as visiting research fellow in 2001 to work on cellular MRI and moved to the current position in August 2004. Research interest: cellular and molecular imaging. Grants: Three active NIH grants. Published over 75 peer-reviewed papers and two book chapters. I served as reviewer in NIH and NSF study sections.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Illustrate the current trend in cellular magnetic resonance imaging.
2) Discuss how to use autologous stem cells and CTLs as cellular probes for MRI.
3) Review magnetic cell labeling techniques.

Presentation Summary
Despite extensive treatment strategies and investigations, the prognosis of glioblastomamultiforme is still poor. The main reason is the inability to delineate the margin of the tumor during routine investigations or during surgery. Moreover, current imaging modalities fail to differentiate, conclusively, the recurrent or left over tumor from radiation necrosis or necrotic tissues. For proper management and follow up it is of the utmost importance to detect recurrent tumor as early as possible. One distinguishing characteristic, however, is that there is little active angiogenesis at the site of radiation necrosis. By determining the differential migration and incorporation patterns of labeled endothelial progenitor cells (EPCs) at the site of glioma, it should be possible to differentiate between radiation necrosis and recurrent glioma (1, 2). Recently dendritic cell-based vaccination and cytotoxic T-lymphocytes (CTL) are being considered for the treatment of recurrent glioma. In the animal models as well as in the early phases of clinical trials, CTL has been shown to accumulate in the glioma (3). By tracking the migration and hom-
ing of CTL it also may be possible to differentiate recurrent glioma from radiation necrosis. If this proves feasible, a translation into clinical trials can quickly follow, employing autologous labeled EPCs or CTLs. Moreover, EPCs can carry therapeutic or suicidal gene that can be targeted later to destroy tumor cells or tumor. In this lecture, current strategy to use cells as probes for MRI as well as therapeutic vehicles will be discussed and results from ongoing animal experiments for brain tumors will be shown.

REFERENCES

Molecular Neuroimaging of Brain Tumors: The Link Between Clinical Molecular Medicine?
Cameron W. Brennan, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss the molecular heterogeneity of high-grade glioma.
2) Review practical techniques of targeted tumor biopsy using intraoperative MRI.
3) Identify uses and limitations of mouse brain tumor models for molecular imaging and preclinical trials.

PRESENTATION SUMMARY
Molecular imaging is particularly well suited to the biology and treatment of malignant brain tumors. High-grade gliomas are heterogeneous in their histopathology and molecular characteristics and are invasive into normal brain. MR imaging interpretation of therapeutic response is indirect and is complicated by confounding effects. Noninvasive and specific measures of therapeutic response are perhaps the most critical potential applications for molecular imaging in glioma; there is little time to change therapies in a disease with 12-month median survival. While emerging modalities for imaging apoptosis, cell proliferation and EGFR mutation are of keen interest, validation of molecular imaging is a critical step to close the loop between experimental modalities and potential application as a biomarker. Validation may be attempted through genetically defined mouse models which recapitulate a complete spectrum of human tumor pathology, and through the use of brain tumor biopsy targeted by imaging features.

Wednesday Afternoon
1:15 PM – 2:45 PM
Room 211/212

(43) General Session: How I Do It...
Postoperative Neck and MS

(283) Postoperative Neck
— Lawrence E. Ginsberg, MD

(284) Multiple Sclerosis
— M. Matilde Inglese, MD, PhD
Moderator: Lawrence E. Ginsberg, MD

Postoperative Neck
Lawrence E. Ginsberg, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the common head and neck surgical procedures and their postoperative imaging appearances.
2) Review the strategies, modalities, and approaches to imaging the postoperative head and neck patient.
3) List the various postoperative complications and their imaging appearance.

PRESENTATION SUMMARY
Treatment of the head and neck cancer will often include surgery at some point. This may take the form of up-front or primary therapy, be performed as part of a staged therapy to occur after induction or other therapy, or be of a salvage nature after primary therapy has failed. Once surgery has taken place, the radiologist often is faced with a very challenging imaging appearance, and must be familiar not only with the expected appearance after successful surgery, but also be able to recognize when that surgery has in some way failed, either because of incomplete tumor resection, tumor recurrence, or one of the many operative complications that can occur. Occasionally, several of these possibilities may co-exist. Generally, the operated neck will never be the same again. In addition, the adage “you can't make an omelet without breaking a few egg” has particular application to imaging the postoperative neck. The goal of this presentation will be several fold; to present the rationale and indications for some of the most commonly performed surgeries for head and neck cancer, review issues pertaining to postoperative imaging including timing and choice of imaging modality, review the typical imaging appearance following these surgeries, and to describe the imaging appearance of tumor
recurrence, differentiation from simple postoperative change when possible, and present some of the common postoperative complications.

Multiple Sclerosis
M. Matilde Inglese, MD, PhD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Discuss the role of MRI in the diagnosis of multiple sclerosis.
2) Illustrate the new MRI criteria for the early diagnosis of multiple sclerosis.

Presentation Summary
Multiple sclerosis (MS) is a clinical diagnosis which requires the integration of clinical and paraclinical tools such as magnetic resonance imaging (MRI). A recent revision of the diagnostic guidelines for MS has formalized the use of MRI along with the clinical picture. These new guidelines should provide for the earlier and easier diagnosis of MS and be useful for both neurologic practice and clinical trials.

Wednesday Afternoon
3:15 PM – 4:45 PM
La Louisiane Ballroom

(45a) Socioeconomics & Anatomy
(Scientific Papers 286 – 296)

See also Parallel Sessions
(45b) ADULT BRAIN: Vascular, Intracranial
(45c) SPINE: Degenerative, Inflammatory Infectious, Demyelinating Diseases/Excerpta
(45d) INTERVENTIONAL: New Techniques and Devices

Moderators: Patrick A. Turski, MD
David J. Seidenwurm, MD

Paper 286 Starting at 3:15 PM, Ending at 3:25 PM
Special Update - NSF

Eric J. Russell, MD, FACR
Northwestern University
Chicago, IL

Paper 287 Starting at 3:25 PM, Ending at 3:33 PM
Participation of an Academic Neuroradiology Division in a Peer-to-Peer Ordering Support Program: Follow Up of “Procedures Not Performed” and the Power of the Sentinel Effect

Friedman, D. P.¹ · Smith, N. S.¹ · Bree, R. L.² · Rao, V. M.¹
¹Jefferson Medical College/Thomas Jefferson University Hospital, Philadelphia, PA, ²University of Washington Medical Center, Seattle, WA

Purpose
To analyze the eventual outcome of “procedures not performed” as the result of the participation of an academic neuroradiology division in a peer-to-peer ordering support program (HealthHelp RadConsult).

Materials & Methods
Using evidence-based guidelines, a commercial utilization management company (HealthHelp) provides real-time decision support for physicians ordering high cost, outpatient imaging studies on patients enrolled in national and local health plans. After initial consultation between RadConsult personnel and the referring physician’s staff, studies not meeting appropriateness criteria are referred to an academic neuroradiologist for further review. The radiologist can approve the study based upon the electronic chart review, or call the referring physician for further information. We ana-
lyzed the eventual outcome of outpatient, neuroradiologic CT and MRI studies ordered during a 1-year interval (July 2006-July 2007), but initially not performed as a result of the RadConsult review process involving the radiologist. Duration of follow up was at least 3 months, and as long as 15 months, after the initial order for the study. Seven neuroradiologists participated in this project. Patients were enrolled in a national health plan.

RESULTS
Two hundred fifty-eight studies were not performed after telephone consultation between the referring physician and radiologist; of these, only 63 (24%) eventually were reordered and processed to be performed. Median interval to reordering for MRI spine (30 studies) was 31 days and for CT sinus (9 studies) was 20 days. One hundred fifty-two studies were not performed due to “no callback” within 48 hours from the referring physician; of these, only 54 (36%) eventually were reordered and processed to be performed (median time to reordering was 16 days). Overall, 293/410 (71%) of studies initially not performed were not reordered.

CONCLUSION
Implementation of a radiology peer-to-peer ordering support program results in a durable reduction in the performance of high cost, outpatient imaging studies. Studies not performed after consultation between the referring physician and radiologist usually were not reordered. For the most common studies subsequently processed to be performed, the median time interval to reordering suggests that the radiologist’s recommendations for evidence-based management usually were followed. Furthermore, studies not performed simply due to lack of a response from the referring physician to the radiologist’s telephone call usually were not reordered. These results demonstrate strongly the decrease in utilization of diagnostic imaging prompted by the process of external review (“sentinel effect”), and we believe that they have significant implications for the overall cost of health care.

KEY WORDS: Utilization management, sentinel effect

Paper 288 Starting at 3:33 PM, Ending at 3:41 PM
Cost Savings Associated with the Participation of an Academic Neuroradiology Division in a Peer-to-Peer Ordering Support Program

Friedman, D. P. · Smith, N. S. · Bree, R. L. · Rao, V. M.
1Jefferson Medical College/Thomas Jefferson University Hospital, Philadelphia, PA. 2University of Washington Medical Center, Seattle, WA

PURPOSE
To analyze cost savings by modality (CT and MRI) associated with the participation of an academic neuroradiology division in a peer-to-peer ordering support program (HealthHelp RadConsult).

MATERIALS & METHODS
Using evidence-based guidelines, a commercial utilization management company (HealthHelp) provides real time decision support for physicians ordering high cost, outpatient imaging studies on patients enrolled in national and local health plans. After initial consultation between RadConsult personnel and the referring physician’s staff, studies not meeting appropriateness criteria are referred to an academic neuroradiologist for further review. The radiologist can approve the study based upon the electronic chart review, or call the referring physician for further information. Studies are not denied by the radiologist. Evidence-based educational materials can be sent to the provider. We analyzed the aggregate cost savings by modality (CT and MRI) associated with outpatient, neuroradiologic studies ordered during a 1-year interval (July 2006-July 2007), but not performed as a result of the RadConsult radiologist review process. Seven neuroradiologists participated in this project. Patients were enrolled in a national health plan.

RESULTS
A total of 2032 studies were reviewed. Of these, 1622 were performed by consensus. The remaining 410 studies (293 MRI, 117 CT) were not performed initially. One hundred seventeen studies (85 MRI, 32 CT) eventually were reordered and processed to be performed; these studies were excluded from the cost-savings analysis. Two hundred ninety-three studies (208 MR, 85 CT) initially not performed were not reordered. Overall, 71% of MRI studies and 73% of CT studies initially not performed were not subsequently reordered (duration of follow-up, 3 to 15 months). Assuming an average global reimbursement rate of $600 per MRI study and $250 per CT study, the approximate aggregate dollar savings for the payors was $148,175 (exclusive of administrative costs of the RadConsult program). Eighty-four percent of these savings ($124,800) were related to MRI studies not performed.

CONCLUSION
Real-time decision support provided by academic neuroradiologists to referring physicians resulted in a substantial reduction in the cost of outpatient neuroradiologic imaging. The vast majority of these savings were related to MRI studies not performed. Savings were achieved despite the fact that the participating radiologists do not deny studies. Moreover, our results do not incorporate potential long-term savings achieved through changes in the utilization of diagnostic imaging by providers as the result of clinical assessment collaboration and education.

KEY WORDS: Utilization management, cost savings

Paper 289 Starting at 3:41 PM, Ending at 3:49 PM
Predicting and Comparing Costs of Major and Minor Stroke Patients Using a Neuroimaging Classification System

Cipriano, L. · Steinberg, M. · Gazelle, S. · Gonzalez, R. G.
1Massachusetts General Hospital, Boston, MA. 2Harvard University, Cambridge, MA

PURPOSE
An ischemic stroke classification system based on neuroimaging with the ability to predict stroke outcomes and acute hospitalization costs would be useful for clinical prognostication and hospital resource planning. One such classification system, the Boston Imaging Stroke Scale (BISS), was tested in stroke patients at an urban academic medical center.
**Materials and Methods**

Ischemic stroke patients who presented in the emergency department in 2000 (235 patients) and 2005 (250 patients) were classified as having either a major or minor stroke using the BISS. Patients with a proximal cerebral artery occlusion (internal carotid artery, proximal middle cerebral artery or basilar artery) identified using CT or MR angiography or, if no occlusion, imaging evidence of significant parenchymal ischemia were classified as having a major stroke. All others were classified as minor strokes. Outcomes included death, length of hospitalization, discharge disposition, use of hospital resources (imaging and intensive care), and total cost.

**Results**

In both years, patients identified as having a major stroke by imaging had a significantly longer length of stay, spent more days in the ICU, and had a higher cost of hospitalization than patients identified as having a minor stroke (all outcomes p < 0.0001). All deaths (9 in 2000, 23 in 2005) occurred in patients with a major stroke. Whereas 73% of minor stroke patients were discharged home, only 12.2% of major stroke patients were discharged home (p < 0.0001); 61% of major stroke patients were discharged to a rehabilitation or skilled nursing facility. Major stroke patients cost 4.4 times and 3.0 times the cost of minor stroke patients in 2000 and 2005, respectively. Making up less than one third of all patients, major stroke patients accounted for 60% of the total cost of acute stroke care.

**Conclusion**

The neuroimaging-based Boston Imaging Stroke Scale is highly effective at predicting in-hospital resource use, acute-hospitalization cost, and outcome. Predictive ability was maintained across years studied. Comparisons to the predictive ability of clinical scales are needed.

**Key Words:** Stroke, costs, classification

**Purpose**

To analyze aggregate data on vertebroplasty and kyphoplasty volumes and payer-perspective costs.

**Materials and Methods**

Thoracic and lumbar vertebroplasties and related imaging procedures received unique CPT codes effective 1/2001. Kyphoplasty received analogous codes effective 1/2006. Vertebroplasty and kyphoplasty (all anatomical sites combined) received unique ICD-9-CM procedure codes effective 10/2004. Using CPT codes applied to data from sources including Medicare’s Part B Extract and Summary System (BESS), we augmented prior vertebroplasty rate calculations for 2001-2005(1) with rates for individual states. We then estimated Medicare-allowed Part A and Part B facility and physician charges (including imaging charges) for allowed claims for inpatient and outpatient vertebroplasties performed in Part B fee-for-service enrollees. We also reviewed BESS data on volumes and Medicare-allowed *Part B* charges for vertebroplasties and kyphoplasties performed in 2006. Allowed charge figures combining expected contributions from both insurers and patients reflect costs from various payer perspectives. Where noted, they were expressed in 2006 dollars using the Producer Price Index. Finally, we queried on-line versions of Healthcare Cost and Utilization Project (HCUP)’s Nationwide Inpatient Sample (NIS) to estimate nationwide all-payer volumes of inpatient vertebroplasties and kyphoplasties performed from 10/2004-12/2005.

**Results**

See Table. Vertebroplasty rates for individual states ranged from 0.0-515.6/100,000 Medicare Part B fee-for-service enrollees in 2001 (median state rate=35.4), rising to 9.8-849.5/100,000 in 2005 (median state rate=75.0). Inpatient cases (~40%) accounted for >70% of total charges annually. In 2006, Part B fee-for-service enrollees underwent 29,199 vertebroplasties (88.9/100,000) and 42,841 kyphoplasties (130.4/100,000). Aggregate Part B fee-for-service costs totaled $26.4 million for vertebroplasty and $31.8 million for kyphoplasty. Analogous vertebroplasty charges from 2005 totaled $25.4 million (in 2006 $). Per NIS estimates, there were 3,334 inpatient vertebroplasties from 10/12/2004 in the US, and 12,457 from 1-12/2005. Medicare Part A (managed care or fee-for-service) enrollees accounted for 10,290 cases in 2005. There were 7,049 inpatient kyphoplasties from 10-12/2004. The 37,449 inpatient kyphoplasties from 1-12/2005 included 32,200 performed in Medicare Part A enrollees.

**Conclusion**


**Table:** Nationwide Rates and Payer Perspective Medical Costs for Vertebraplasty and Imaging Guidance in Medicare Part B Fee-for-Service Enrollees, 2001-2005

<table>
<thead>
<tr>
<th>N</th>
<th>Mean cost</th>
<th>Mean cost</th>
<th>Mean cost</th>
<th>Mean cost</th>
<th>Mean cost</th>
<th>Mean cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>All procedures (original $)</td>
<td>14,142</td>
<td>$4,626</td>
<td>19,341</td>
<td>$5,104</td>
<td>24,556</td>
<td>$5,190</td>
</tr>
<tr>
<td>All procedures (2006 $)</td>
<td>14,142</td>
<td>$5,613</td>
<td>19,341</td>
<td>$6,027</td>
<td>24,556</td>
<td>$5,828</td>
</tr>
<tr>
<td>Ambulatory surgery center procedures (original $)</td>
<td>48</td>
<td>$645</td>
<td>67</td>
<td>$577</td>
<td>80</td>
<td>$559</td>
</tr>
<tr>
<td>Office-based procedures (original $)</td>
<td>173</td>
<td>$585</td>
<td>151</td>
<td>$573</td>
<td>194</td>
<td>$577</td>
</tr>
<tr>
<td>Hospital-based outpatient procedures (original $)</td>
<td>7,990</td>
<td>$1,805</td>
<td>10,657</td>
<td>$2,307</td>
<td>13,558</td>
<td>$2,232</td>
</tr>
<tr>
<td>Office-based procedures (original $)</td>
<td>14,142</td>
<td>$79.4</td>
<td>19,341</td>
<td>$6,027</td>
<td>24,556</td>
<td>$5,828</td>
</tr>
</tbody>
</table>

Data on annual vertebroplasty rates and on volumes by treatment site also appear in Gray et al (1).
charges (as captured for vertebroplasty in the Table’s last row). Practice patterns, costs and outcomes of vertebral augmentation bear ongoing review.

REFERENCES

KEY WORDS: Vertebroplasty, kyphoplasty, socioeconomics

Paper 291 Starting at 3:57 PM, Ending at 4:05 PM
Direct Imaging of the Distal Dural Ring and Paraclinoid Internal Carotid Artery Aneurysm with High-Resolution T2 Turbo Spin-Echo Technique at 3.0 T MR Imaging

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PURPOSE
To evaluate the clinical feasibility of direct visualization of the distal dural ring (DDR) and adjacent anatomical structures in paraclinoid internal carotid artery aneurysm patients at 3.0 T magnetic resonance imaging (MRI).

MATERIALS & METHODS
Six consecutive patients [male:female=1:5, mean age=45.5 years (34~51)] who underwent 3.0 T MRI examinations for the evaluation of seven paraclinoid carotid artery aneurysms were reviewed retrospectively. MR images were acquired with using T2 turbo spin-echo sequence, 2 mm thickness without gap on the coronal plane perpendicular to the diaphragma sellae. Identification of distal dural ring, adjacent regional anatomical landmarks and paraclinoid aneurysm were analyzed. Location of paraclinoid aneurysm was categorized into intradural (aneurysm is mainly located beyond the distal dural ring), transdural (about 50% of aneurysm sac is located beyond the distal dural ring but otherwise below the distal dural ring) and extradural (the aneurysm is located below the distal dural ring).

RESULTS
In all cases, the DDR was clearly identified and the relationship between the DDR and paraclinoid aneurysm was determined successfully on 3 T MRI scans (4 intradural, 1 transdural and 2 extradural located aneurysms).

CONCLUSION
Direct visualization of the distal dural ring as well as precise evaluation of paraclinoid aneurysm location with high-resolution 3 T MRI is possible. We believe high-resolution 3 T MRI technique could be an important imaging method to determine appropriate management option for paraclinoid aneurysm patients.

KEY WORDS: Distal dural ring, 3 T MRI

Paper 292 Starting at 4:05 PM, Ending at 4:13 PM
Identification of Motor Strip: Value of the Echo-Planar Imaging T2 and Quantitative Apparent Diffusion Coefficient Measurement at 3 T

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Istanbul, TURKEY

PURPOSE
The purpose of the study was to evaluate signal intensity changes due to T2 shortening of the motor strip and the quantitative apparent diffusion coefficient (ADC) measurement of motor strip, compared to superior frontal cortex both in normal adults and patients with lesions adjacent to the central sulcus on EPI T2-weighted images as a part of routine brain MRI examination at 3 T.

MATERIALS & METHODS
Echo-planar imaging (EPI) T2 (b0), b1000 ve b 2000 images of 134 neurologically normal patients and 24 patients with the lesions adjacent to the motor cortex were evaluated retrospectively. The patients were chosen randomly. Signal intensity of the motor strip was graded by authors as either isointense or hypointense when compared to signal intensity of the superior frontal cortex. Quantitative ADC measurements for the motor strip and superior frontal cortex were derived on a manually traced region of interest. Location of central sulcus was confirmed with standart anatomical landmarks in both groups and by fMRI in 24 patients.

RESULTS
The motor strip was isointense in 2, hypointense in 132 normal adults. The motor strip was hypointense in all patients. The measurements of the ADC values of the motor strip and the superior frontal sulci were statistically different in both groups.

CONCLUSION
Identification of the motor strip on MR can be difficult especially in the presence of mass effect due to obscured cortical landmarks. It is proved that T2 shortening in the motor cortex is readily demonstrated with EPI T2 images at 3 T. This could be a valuable complementary method to identify the central sulcus with or without the application of advanced imaging techniques. Diffusion-weighted imaging with b0 (EPI T2) as a part of routine brain examination could give us valuable complementary information in terms of the identification of the motor strip in a simple way at 3 T.

KEY WORDS: Motor strip, ADC
Fenestrations of the Anterior Communicating Artery: Incidence on 3D Angiography and Relation with Aneurysms

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**Purpose**
The purpose of this study was to assess the incidence of visible anterior communicating artery (AcomA) fenestrations on 3D rotational angiography (3D RA) and to evaluate relation between AcomA fenestrations and AcomA aneurysms.

**Materials & Methods**
Three hundred five internal carotid artery 3D datasets in 305 patients with anterior circulation aneurysms were reviewed systematically on a dedicated workstation for the presence of fenestrations on the anterior communicating artery.

**Results**
In 78 of 305 3D RAs, only the ipsilateral A2 was visible and the AcomA thus could not be evaluated. Of the remaining 227 3D RAs an AcomA fenestration was present in 12 (5.3%, 95% CI 3.0-9.1%). Of 12 AcomA fenestrations, 10 (83%) were associated with one or more AcomA aneurysms. Of 305 patients, 133 had an aneurysm on the anterior communicating artery and in 127 of these the AcomA was visible. Of 127 AcomA aneurysms with visible AcomA, 10 were associated with fenestration accounting for an incidence of AcomA fenestration with AcomA aneurysms of 7.9% (95% CI 4.2-14.0%). The proportion of AcomA fenestration with an AcomA aneurysm was 4.4% (10 of 227) and the proportion of AcomA fenestration with an AcomA aneurysm at another location was 0.9% (2/227). This difference was statistically significant (p = 0.040). Even in retrospect, 11 of 12 fenestrations were not visible on 2D DSA images.

**Conclusion**
With 3D RA, fenestrations in the anterior communicating artery were found in 5.3% of datasets in patients with anterior circulation aneurysms. Most fenestrations were associated with one or more anterior communicating artery aneurysms.

**Key Words:** Fenestration, aneurysms, 3D angiography

High-Resolution MR Microscopy and Micro Diffusion Tensor Imaging of the Human Spinal Cord at 9.4 T: A Postmortem Study

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

**Purpose**
Conventional in vivo MR imaging displays the gross structure of the spinal cord, but not the fine internal architecture. Earlier work showed that 9.4 T MR microscopy (MRM) with intermediate-weighted sequences achieves high-resolution images of the cerebral cortex and brainstem and successfully depicts individual neocortical layers, each cranial nerve nucleus, complex spiraling interdigitations of long white matter tracts, and specific vascular compartments of the brain. We hypothesized that 9.4 T MRM and microdiffusion tensor imaging (MicroDTI) would display successfully the fine internal architecture of the cord and provide criteria for identifying individual structures within gray matter and white matter columns.

**Materials & Methods**
Sections from 10 formalin-fixed normal adult human spinal cord were scanned at 9.4 T using a superconducting magnet with 89 mm bore and 30 mm birdcage coil (Bruker Avance, Bruker Analytik, Rheinstetten, Germany) to provide high-resolution proton-density anatomical images in three orthogonal planes (voxel size: 43x43x500µm). Matching MicroDTI were obtained using multishot echo-planar sequences in 6 directions. MicroDTI was processed using DTI Studio (Johns Hopkins University, Baltimore, MD) to generate fractional anisotropy, diffusivity, and fiber tract direction-encoded color maps matching the anatomical images. These datasets were correlated specifically with histological sections of the same specimens, stained with Nissl and Luxol fast blue, to document the specific gray and white matter structures displayed by imaging.

**Results**
Sequential MRM and microDTI successfully demonstrate the fine structure within the gray and white matter of the cord at the cervicomedullary junction, cervical enlargement, midthoracic cord, lumbar enlargement, and conus. The two techniques proved complementary for resolving Rexed zones I-X of gray matter, specific structures within the dorsal and ventral gray, and the white matter commissures of the cord and complex courses of white matter tracts within the peripheral columns of the cord. The arterial and venous compartments of the cord are identified by virtue of the entry/exit points of their vessels. Pseudo-cineloops generated from MRM were particularly useful for understanding the interrelationships among structures. The hypothesis is proved.

**Conclusion**
MR microscopy and MicroDTI at 9.4 T depict the nuclear and fiber tract anatomy of the spinal cord in great detail. Correlation with histological sections of the same specimens confirms the identifications made by neuroimaging. The images provide an excellent way to learn this complex anato-
my in three dimensions. We expect that advances in clinical imaging soon will require neuroradiologists to learn at least some of the anatomical details discussed in this report.

**KEY WORDS:** High-resolution, cord, Rexed

**Paper 295 Starting at 4:29 PM, Ending at 4:37 PM**

**Best MR Anatomical Landmark to Localize L1 Vertebral Body**

Thamburaj, K. · Nguyen, D. T.

Penn State Hershey Medical Center

Hershey, PA

**PURPOSE**

L1 spine vertebral body on MRI is localized mainly by counting up from the lumbosacral junction. Transitional anatomy may interfere with this counting method and various authors have used different methods suggested such as the origin of visceral arteries, aortic bifurcation and iliolumbar ligament to localize L1. This study was developed to assess the best reliable MR anatomical landmark located near L1.

**MATERIALS & METHODS**

In this retrospective study, 311 cases were chosen from 1300 consecutive cases of lumbar spine MRI done from July 2006 to January 2007. We excluded patients with age 5 and less and those with congenital anomalies. MRI lumbar spine was done with 1.5T MRI in sagittal and axial planes with T1 and T2 sequences and MR myelogram. L1 was localized by counting from C1 and its relationship to the lowermost rib, origin of psoas, celiac artery (CA) and superior mesenteric artery (SMA) origins and termination of conus were assessed. A null value of 0.90 was considered significant and statistical analysis was performed with an exact version of the one sample binomial test. Ninety-five percent exact confidence interval was used to assess the precision of the estimate.

**RESULTS**

Among 311 cases, there were 165 females and 146 males. The age of the patients ranged from 6 to 87 years (mean 44.83 ± 21.91SD). The lowermost rib correlated with T12 and would have localized L1 in 297 cases (95.5%), psoas origin would have localized L1 in 290 cases (93.3%), termination of conus in 158 cases (50.8%), CA origin in 70 cases (22.5%) and SMA origin in 181 cases (58.2%). The exact 95% confidence interval for localizing L1 with lowermost rib was 92.6% to 97.5% (p <0.001), with psoas origin 89.9% to 95.8% (p 0.06), with SMA origin 52.5% to 63.7% (p <0.001), with termination of conus 45.1% to 56.5% (p <0.001) and with CA origin 18% to 27.6% (p <0.001). Transitional anatomy was observed in 39 cases (12.5%) with 26 lumbarizations and 13 sacralizations. Five of twenty-six lumbarizations showed the lowermost rib on L1 and 12 showed psoas origin on L2. Forty-six percent lumbarizations would have been identified from L2 psoas origin and L1 rib. Two of thirteen sacralizations showed psoas origin at T12 and 4 showed lowermost rib on T11. Thirty percent sacralizations would have been identified from T12 psoas origin and T11 rib.

**CONCLUSION**

Counting down from C1 is the best method to localize L1. If one chooses to use an adjacent structure to localize L1 for various reasons, we recommend using lowermost rib as the best reliable anatomical marker. Psoas origin is the second best marker to localize L1. Conus, CA origin and SMA origin are unreliable to localize L1. Transitional anatomy is observed in one tenth of cases and approximately half of these can be identified from T12 or L2 psoas origin and T11 or L1 rib.

**KEY WORDS:** Lumbar vertebra, MRI

**Paper 296 Starting at 4:37 PM, Ending at 4:42 PM**

**Internal Carotid Artery Venous Plexus of Rektorzik: Rediscovered by Contrast-Enhanced Flat Panel Computed Tomography and 3D Digital Subtraction Angiography**

Benndorf, G.

The Methodist Hospital Research Institute

Houston, TX

**PURPOSE**

The internal carotid artery venous plexus (ICAVP) has been described first by Rektorzik in 1858 as *pars intracanalum sinus caroticus*, was observed as *inferior petrooccipital vein* by Trolard, or as *sinus venous caroticus* after Haike, and descends from the inferior cavernous sinus (CS) enclosing the carotid artery more or less completely at the lower part of the carotid canal. Due to its complex structure, small lumen and its posterolateral orientation, the ICAVP is barely visible on routine angiograms. It has been largely neglected in recent anatomical descriptions and major textbooks. The purpose of this study is to study the topographic anatomy of the ICAVP plexus and its relationships to adjacent veins with high-resolution cross-sectional vascular imaging using contrast-enhanced flat panel CT (FP CT, DynaCT) and 3D DSA.

**CASE REPORT**

In five patients undergoing petrosal sinus sampling, 3D DSA of the IPS/IJV junction 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 28ml (300mg Iodine). Dual volumes were obtained by separate reconstructions of mask and filling runs and subsequent fusion using a dedicated commercially available workstation (Leonardo, Siemens Medical Solution). Contrast-enhanced FP CTs were performed using the following parameters: 20 sec CTs were performed using the following parameters: 20 sec rotations, 0.4° increment, 219° total angle, 1240x960 detector matrix, 543 projections, “bone sharp” kernel, 512x512 reconstruction matrix, 20% dilution (300mg Iodine), 2cc/sec, total of 40 ml. Image post-processing was performed using maximum intensity projections (MIPs) and volume renderings (VRTs).

**IMAGING FINDINGS**

After emerging from the CS, Rektorzik’s plexus initially appears more like a continuous venous structure, lining the osseous petrous canal and covering the wall of the carotid artery with a very thin inner lumen. Following the course of the ICA, the plexus travels more laterally than the other efferent veins and seemed to transform into a network of small veins, appearing more like a plexus. In this material,
this plexus-like structure ended somewhere in the carotid canal of the petrous pyramid and was not connected directly with the IPS, but gave rise to a very small curved vein that courses medially to reach the IPS/IVJ junction. The IPCV arises between Rektorzik’s plexus and the inferior petrosal sinus and courses almost in parallel to the IPS, posterolaterally and caudally towards the IPS/IVJ junction.

**SUMMARY**
Rektorzik’s plexus appears to be a constant venous outlet of the CS, emerging between the emissary vein of the foramen ovale and the IPCV, and creating a consistent anatomical arrangement of four efferent veins arising from the lateral and lateroposterior CS: 1) Foramen ovale plexus, 2) Internal carotid artery venous plexus (ICAVP), 3) Inferior petroclival vein (IPCV), 4) Inferior petrosal sinus (IPS).

**REFERENCES**

**KEY WORDS:** Rektorzik’s plexus, contrast-enhanced flat panel CT, 3D DSA

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**Wednesday Afternoon**

**3:15 PM – 4:45 PM**
**Room 206/207**

(45b) ADULT BRAIN: Vascular, Intracranial
(Scientific Papers 297 – 308)

**See also Parallel Sessions**
(45a) Socioeconomics & Anatomy
(45c) SPINE: Degenerative, Inflammatory Infectious, Demyelinating Diseases/Excerpta
(45d) INTERVENTIONAL: New Techniques and Devices

**Moderators:** Pina C. Sanelli, MD
Paul E. Kim, MD

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**Paper 297 Starting at 3:15 PM, Ending at 3:23 PM**

**Left-Sided or Right-Sided Injection in Neuro-CT Angiography. Does It Matter? If So, How Much? Assessing Degree of Opacification and Artifacts from Hyperdense Venous Inflow and Reflux**

Pomerantz, S. R. · Dabydeen, D. A. · Kamalian, S. M. · Gonzalez, R. G. · Lev, M. H.
Massachusetts General Hospital
Boston, MA

**PURPOSE**
Choice of side for intravenous contrast injection in CT angiography (CTA) typically reflects venous access considerations rather than scan quality. We assessed whether side of contrast injection influences degree of arterial opacification and the amount of obscuration from hyperdense venous inflow and reflux.

**MATERIALS & METHODS**
One hundred forty-eight consecutive CTAs of the head and neck performed on a 64-slice scanner were evaluated retrospectively. Patients received iodinated contrast either via right- or left-sided injections into the antecubital or wrist veins using a standard multiphasic injection protocol with saline flush. CT density was measured in the aortic arch (AA), right carotid bifurcation (RCB) and at the right internal carotid artery (RICA) terminus. The extent of reflux of inflowing hyperdense venous contrast up the internal jugular vein (IJV) was graded (mild: below cricoid, severe: above cricoid). Obscuration from hyperdense contrast of arterial segments on standard maximal intensity projections (MIPs) was graded (none, partial, complete). Correlation with axial source images was performed to determine if an obscured segment could still be diagnostic. Any inflow stenosis was noted.

**RESULTS**
Right arm injection (RAI) resulted in higher mean density compared to left arm injection (LAI) at all three levels: AA (440 HU ± 109 vs 404 ± 112, P = 0.03), RCB (461 HU ± 111 vs 420 ± 104, P = 0.01), and RICA (400 HU ± 92 vs 358 ± 90, P = .003). Overall, total number of cases with any reflux into the IJV was larger with LAI (LAI 31%, RAI 17%, P = 0.05). The relative difference was even larger for the severe reflux subgroup (LAI 18%, RAI 3.9%, P = 0.025). Partial obscuration of the ipsilateral common carotid artery was greater from LAI (LAI 31%, RAI 9%, P = 0.025). Trends toward greater obscuration from LAI were seen in many other artery segments. There was left brachiocephalic vein stenosis in 45% of cases with severe reflux.

**CONCLUSION**
Left-sided CTA injection results in lower mean neurovascular attenuation and a larger percentage of cases with obscured arterial segments on MIPs. Whenever possible, injection for neuro-CTA should be from the right to optimize scan quality.

**KEY WORDS:** CTA, MIPs, contrast
Evaluation of Cerebral Arteriovenous Malformations by 3 T Time-Resolved Contrast-Enhanced MR Angiography at Six Frames per Second

Hurley, M. C. · Jeong, H. J. · Eddleman, C. S. · Bendok, B. R. · Shaibani, A. · Batjer, H. H. · Carroll, T. J.
Northwestern Memorial Hospital
Chicago, IL

Purpose
To evaluate the accuracy of a new MR pulse sequence in the detection and depiction of clinically relevant AVM anatomy according to the Spetzler-Martin classification, using digital subtraction angiography (DSA) as the gold standard.

Materials & Methods
Eight consecutive patients with cerebral AVMs due to undergo stereotactic DSA prior to gamma-knife radiosurgery were enrolled to also undergo a time-resolved contrast-enhanced MRA (TR/CE MRA). Stereotactic DSA was performed on a Neurostar biplane angiography unit (Siemens, Erlangen, Germany) by selective contrast injection of all territories. Time-resolved/CE MRA was performed on a 3 T whole-body MR scanner (Trio, Siemens, Erlangen, Germany) by selective contrast injection of all territories feeding the lesion with angiography at six frames/sec in standard orthogonal anteroposterior, lateral and oblique projection. Time-resolved/CE MRA was performed on a 3 T whole-body MR scanner (Trio, Siemens, Erlangen, Germany) within several weeks of the DSA examination. Intravenous 0.1 mmol/kg gadolinium (Magnevist, Berlex, Wayne, NJ) was injected at 4ml/sec. Our imaging sequence exploited increased 3 T signal, acceleration techniques including radial k-space undersampling and pseudorandom view ordering, sliding scale windowing and a sliding subtraction technique. We achieved a sagittal field of view of 220x220x75mm with pixel resolution of 1.1x1.1x2.8mm and frame rate of 6/sec. Lateral projection maximum-intensity-projection cine images were generated and stored on a workstation. MRA images were assessed initially by a neuroradiologist blinded to the patient information. Arteriovenous malformations were graded according to size and venous drainage. Flow-related and nidal aneurysms, varices, venous stenoses and number of draining veins also were recorded. The DSA examinations then were reviewed together with MRA studies to assess accuracy of initial interpretation. Standard MR brain imaging was assessed to determine lesion location and eloquence.

Results
Eight patients were assessed by TR/CE MRA and DSA over a period of 12 months. Mean age was 40.1+/−14.4 with a male to female ratio of 3:5. Digital subtraction angiography demonstrated seven supratentorial and one infratentorial (cerebellar hemisphere) AVMs. All supratentorial lesions were located in hemispheric cortex/deep white matter and five involved eloquent regions (4 motor cortex, 1 Broca’s area). Median volume was 14.9cc with a range of 1.5 to 57.6cc and deep venous drainage was present in two cases with a median Spetzler-Martin grade of 3 and a range of 2 to 4. A total of seven intranidal aneurysms were identified in three patients, three patients had flow-related nidal aneurysms, one patient had a discrete varix and one patient had a hemodynamically significant stenosis of the main draining vein. Time-resolved/CE MRA correctly depicted size, venous drainage and corresponding grade in each case. Minor streak artifacts did not interfere with interpretation. The case with venous stenosis correlated well with DSA study. All intranidal aneurysms were detected prospectively; however one 2mm prenidal aneurysm arising from a posteri or splenial feeder was not detected on MRA study. In retrospect, the aneurysm was faintly visible but the slender parent artery was not.

Conclusion
Optimized high temporal resolution MRA can be employed to accurately grade cerebral AVMs despite high flow shunts. Further refinement of our sliding mask and additional parallel imaging techniques may afford additional spatial and/or temporal resolution and this study is ongoing.

Key Words: MRA, AVM, 3 T
improved kappa value compared with CTP for angiographic vasospasm. CT perfusion had slightly improved sensitivity compared with TCD. However, TCD had higher specificity, positive and negative predictive values for angiographic vasospasm.

CONCLUSION
CT perfusion had slightly improved sensitivity and TCD had better specificity for detection of angiographic vasospasm. Both CTP and TCD are useful tools that can assist in detection of angiographic vasospasm in the clinical setting. CT perfusion is able to detect distal vasospasm improving its detection rate. However, the velocity measurements using TCD correlates better with angiographic vasospasm.

KEY WORDS: Perfusion imaging, aneurysmal subarachnoid hemorrhage

Paper 300 Starting at 3:39 PM, Ending at 3:47 PM
Comparison of CT Perfusion and Digital Subtraction Angiography for Detection of Symptomatic Vasospasm

Ghassemi, A.1 · Sanelli, P. C.1 · Agrawal, V. K.1 · Dascal, D.2 · Comunale, J.1 · Lewis, S.2 · Fattpekar, G.2 · Delman, B.1 · Frontera, J.1 · Law, M.2 1Weill Cornell Medical College, New York, NY, 2Mount Sinai School of Medicine, New York, NY

PURPOSE
Vasospasm continues to be a significant adverse prognostic factor of clinical outcome following aneurysmal subarachnoid hemorrhage (A-SAH), resulting in permanent neurologic deficit, stroke and death. The purpose of this study is to compare the diagnostic accuracy of CT perfusion (CTP) with digital subtraction angiography (DSA) for diagnosis of symptomatic vasospasm.

MATERIALS & METHODS
We performed a multiinstitutional study evaluating patients with A-SAH. The inclusion criteria are patients with CTP and DSA performed within 24 hours of each other. All studies were performed prior to treatment of vasospasm. CT perfusion were performed on a 16-slice multidetector CT scanner. Postprocessing of cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time (MTT) maps were created for both qualitative and quantitative analysis using standard recommendations and guidelines. The reference standard is symptomatic vasospasm determined by retrospective chart review from the clinical exam findings documented by the neurointensivist. Statistical analysis includes kappa values for determination of agreement rates between symptomatic vasospasm with CTP and DSA. The sensitivity, specificity, positive and negative predictive values of CTP and DSA in detection of symptomatic vasospasm is determined, as well as McNemar’s test to evaluate a statistical difference between CTP and DSA.

RESULTS
Preliminary results on 29 patients reveal 18 with perfusion defects on CTP and 16 had vasospasm diagnosis on DSA. However, 22 patients were determined clinically to have vasospasm with 10 patients demonstrating evidence of ischemia on follow-up CT or MRI. CT perfusion had an improved kappa value compared with DSA for symptomatic vasospasm. The sensitivity, specificity, positive and negative predictive values also were improved slightly using CTP.

CONCLUSION
CT perfusion has improved diagnostic accuracy for symptomatic vasospasm compared with DSA due to its ability to also detect small vessel vasospasm. CT perfusion is a potential tool that can assist in detection of symptomatic vasospasm in the clinical setting.

KEY WORDS: Perfusion imaging, aneurysmal subarachnoid hemorrhage

Paper 301 Starting at 3:47 PM, Ending at 3:55 PM
Assessing the Value of CT Perfusion in Improving Clinical Outcomes in Aneurysmal Subarachnoid Hemorrhage Using a Decision Analytic Model

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PURPOSE
CT perfusion (CTP) has potential to aid in earlier and more accurate diagnosis of vasospasm in aneurysmal subarachnoid hemorrhage (A-SAH) patients. However, prior to implementing a new imaging modality in the clinical setting, its clinical usefulness and cost effectiveness needs to be determined. The purpose of this study is to develop a decision analytic model that is able to evaluate the impact of using CTP in A-SAH patients by assessing clinical outcomes and cost effectiveness.

MATERIALS & METHODS
A decision analytic model is developed in A-SAH patients using TreeAge Pro 2006 software program (TreeAge Software, Inc., Williamstown, MA). This model is a visual representation of the complex management of A-SAH patients displayed in a branching diagram called a decision tree. The decision tree is designed to compare two diagnostic strategy branches using a strategic approach for the model construction in the organization of the options, consequences, treatments and outcomes. A measure of quality of life or costs resulting from that particular chain of events is assigned to each branch at the termination node. These measures provide a means of evaluating and comparing the value of each diagnostic strategy. Quality adjusted life years (QALY) is chosen as a measure of evaluating the effect of CTP on clinical outcome and costs in dollars is chosen as a measure of assessing the financial burden on health care resources.

RESULTS
The standard diagnostic strategy branch is divided by chance nodes in a sequential format to include the modalities currently used for vasospasm diagnosis such as clinical exam, transcranial Doppler ultrasound (TCD), and digital subtraction angiography (DSA). The new diagnostic strategy branch differs from the standard strategy by including CTP instead of TCD. Complications associated with diagnostic testing and its costs are included in the branches. The results of each
testing modality leads to management options and its consequences separated by chance nodes; including patient observation, further testing or treatment of vasospasm. The second segment of the decision tree design yields the vasospasm diagnosis options for the different branches in each diagnostic strategy. Probabilities are assigned to each branch based on prior statistical analysis at our institution and literature review. The long-term clinical outcome is represented in the third segment as three health states; including full recovery from A-SAH, stroke or death. The probabilities of these health states are determined from literature review for both treated and untreated patients for vasospasm. Each health state is assigned an established utility score and expected life years. Quality adjusted life years will be determined from the utility score and estimated life years for each health state as a measure of assessing the clinical outcome. The costs associated with each health state also will be obtained from literature review.

CONCLUSION
The decision tree is a model that is able to evaluate the value of using CTP in A-SAH patients by incorporating evidence based medicine to assess both clinical outcomes and cost effectiveness.

KEY WORDS: CT perfusion, aneurysmal subarachnoid hemorrhage

Paper 302 Starting at 3:55 PM, Ending at 4:03 PM

High-Sensitivity CRP as a Predictor of Vasospasm and an Indicator for Statin Therapy in Patients with SAH after Intracranial Aneurysm Rupture

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PURPOSE
Cerebral vasospasm, a common complication of aneurysmal subarachnoid hemorrhage (SAH), often produces stroke and significantly affects morbidity and mortality. Recent literature suggests that acute therapy with statins (the 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors) decreases the risk of developing vasospasm after SAH (1). Evidence indicates that statins prevent stroke and dementia, an effect attributed not only to known cholesterol-dependent actions but also to so-called “pleiotropic effects,” including anti-inflammatory action. Several studies suggest that inflammatory response may play a critical role in the development and maintenance of cerebral vasospasm after SAH. Statin therapy results in decreases in C-reactive protein (CRP), a biomarker of inflammation in patients with coronary artery disease (2). We tested the hypothesis that the level of high-sensitivity C-reactive protein (hs-CRP) may be a predictor of vasospasm and an indicator for statin therapy in patients with aneurysmal SAH.

MATERIALS & METHODS
The authors performed a retrospective analysis of 26 patients admitted to the neurologic intensive care unit with aneurysmal SAH, Hunt-Hess grade I-IV, Fisher grade 1-4, and age range of 34-36 years. Treatment for all patients was based on a standard protocol that included hypervolemic-hemodila-

RESULTS
Vasospasm was diagnosed in 18 patients. High-sensitivity-CRP was increased in all patients with documented vasospasm (5.6-44.0 mg/L). Ten patients were treated with statins in addition to the standard protocol (Simvastatin, 40 mg qd); eight were treated with the standard protocol alone. No patients with low hs-CRP (<3.0 mg/L) developed vasospasm, and none of these eight patients were treated with statins. High-sensitivity-CRP levels were especially high in patients with Fisher grades 3 & 4. Five of eight patients with vasospasm and no statins required interventional procedures for vasospasm treatment. Numbers of procedures per patient ranged from 1 to 3 (mean, 1.2). Only two of 10 patients with high hs-CRP levels who were on statins required interventional treatment for vasospasm (once per patient; mean, 0.2). The degree of vasospasm was mild to moderate in patients on statins and moderate to severe in the nonstatin group.

CONCLUSION
A high hs-CRP level may be a predictor of the severity of vasospasm in patients with aneurysmal SAH. Patients treated with statins developed milder form of vasospasm and required significantly less interventional treatment. The hs-CRP level may become a biomarker to identify patients who would benefit most from statin treatment.

REFERENCES

KEY WORDS: Cerebral vasospasm, CRP, statins
Differences in the Temporal Variation of the Wall Shear Stress Intracranial Aneurysms: Importance of Patient-Specific Inflow Waveforms

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PURPOSE
To investigate the differences in intraneurysmal hemodynamics calculated with computational fluid dynamics (CFD) using idealized volumetric inflow waveforms and patient-specific inflow waveforms measured with 2D phase contrast MR imaging (pcMRI).

MATERIALS & METHODS
Five unruptured cerebral aneurysms of the internal carotid artery were studied. Three-dimensional computational meshes were created from 3D DSA images (Artis dBA, Siemens Medical Solutions). Patient-specific volumetric inflow waveforms were measured with 2D pcMRI (1.5 T Sonata, Siemens Medical Solutions) and quantitative MR angiography (QMRA, Vassol Inc.) (1) in a proximal segment of the parent artery prior to endovascular treatment. The Navier-Stokes equations were solved for unsteady flow conditions (Fluent, ANSYS Inc.) using (A) an idealized average waveform derived from normal subjects (2) and (B) the measured patient-specific waveform. Wall shear stresses (WSS) average (WSSave) and shear stress variation (WSSvar) as deviation of instantaneous WSS magnitude from WSSave were calculated.

RESULTS
Values and spatial distributions for WSSave were similar for the idealized and the patient-specific waveform. However values and spatial distributions for WSSvar differed considerably (figure 1 for aneurysm 2).

CONCLUSION
Idealized and patient-specific waveforms yield approximately the same results for the temporal average of the WSS magnitude. Time averages of the variation of the WSS magnitude however were found to be sensitive to inflow conditions. Variations of WSS have been shown to be possibly correlated with aneurysm formation (3). Patient-specific physiologic flow information may be necessary for a more accurate CFD simulation of hemodynamics in intracranial aneurysms.

REFERENCES

KEY WORDS: Cerebral aneurysms, computational fluid dynamics, hemodynamics

Cerebrovascular Reserve Evaluation on MR Imaging for Intracranial Arteries Stenosis: Feasibility and Interest

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PURPOSE
Endovascular treatment is efficient and diminishes the stroke recurrences but carries a significant periprocedural morbidity and mortality risk. Defining a group of patients at higher risk is relevant when determining the benefit of an interventional approach. Among the four mechanisms of ischemic stroke secondary to intracranial atherosclerosis the most important is hypoperfusion due to an hemodynamic stenosis. In the GESICA study the hemodynamic significance of stenosis appeared to be the unique element associated with stroke recurrence. Perfusion imaging with acetazolamide test is used to evaluate the cerebrovascular reserve. The purpose of this study is to evaluate the feasibility and interest of cerebrovascular reserve study on MRI.

MATERIALS & METHODS
Ten patients with a symptomatic intracranial artery stenosis over 50%. Perfusion MRI with gadolinium and continuous arterial spin labelling (CASL) before and after acetazolamide. Comparison of parametric maps of cerebral blood volume, blood flow and mean transit time before and after acetazolamide. Comparison of parametric maps of cerebral blood flow with CASL before and after acetazolamide and between the two perfusion MRI techniques.

RESULTS
Cerebrovascular reserve study was always feasible and parametrics maps always usable. Three groups of patterns were observed. Patients without significant asymmetry (less than 20%) before and after acetazolamide: four patients with stenosis less than 70%. Patients with an asymmetry but with an improvement after acetazolamide: three patients with stenosis estimated at 50 or 60%. Patients with an asymmetry increased after acetazolamide: three patients with a stenosis over 70%. Continuous arterial spin labelling blood flow maps were close to those obtained with gadolinium, easier to obtain and more reproducible with an absolute calculation of regional blood flow. Lack of gadolinium allows to reduce time between pre and postacetazolamide examination.
CONCLUSION
Evaluation of cerebrovascular reserve with MRI is simple and feasible. Results may be useful to select patients with hemodynamic stenosis. Continuous arterial spin labelling is more simple and easier to use and should be used for intracranial stenosis evaluation before angioplasty and stenting.

KEY WORDS: Cerebral artery, stenosis, perfusion MRI

Paper 305 Starting at 4:19 PM, Ending at 4:27 PM
Lessons Learned from 146 Cases of Intracranial Revascularization: It Is Too Early for Randomized Trial

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PURPOSE
Comparison between safety and efficacy of intracranial revascularization for symptomatic intracranial stenosis (SIS) and the disease’s natural history.

MATERIALS & METHODS
Retrospective analysis of prospectively collected data in a single center between April 2002 and October 2007. Success is defined as less than 50% residual narrowing. Follow-up cerebral angiography was obtained at 3 or 6 months, and office visit at 1 year. Data collection included overall success rate; stroke in 30 days, and 1 year; as well as, restenosis rate.

RESULTS
Total of 122 patients with SIS underwent 146 procedures: degree of stenosis ranged from 65-95% with mean of 80%. Patients were divided into two groups depending on intent to treat: 53 underwent angioplasty and 79 stenting. Ten angioplasty patients needed secondary stenting for either a significant dissection during angioplasty (3) or for stenosis at follow-up angiography (7); they were included in both categories. Fifty-three patients underwent primary angioplasty and 50 were successful (94.3%). Three needed immediate stenting for significant stenosis 3/50 (6%). No clinical event was recorded. Reimaging studies were available in 46 patients [45 catheter angiography, 1 MR angiography (MRA)]. Two patients had total occlusion 2/46 (4.3%), 7 needed secondary stenting 7/46 (15.2%), 13 needed reangioplasty 13/46 (28.2%). Overall, a total of 47.7% required second intervention or had a vascular occlusion. Clinical follow-up was available in 46 patients ranging from 3-59 months with a mean of 19.7 months. Only one stroke was recorded in a different vascular territory 1/46 (2.1%), and none in the territory. Seventy-nine patients underwent stenting; 74 were successful 74/79 (93.6%) with 83 stents. We used 38 balloon-mounted stents, 44 wingspan stents, and one Neuroform stent. Some patients had multiple stents in different vessels. Of 38 balloon-mounted stents, three had an acute stroke 3/38 (7.8%) in the basilar artery. Twenty-seven patients had angiographic follow up [22 catheter angiograms, 2 MRA, 3 CT angiograms, (CTA)]. Restenosis occurred in one patient 1/27 (3.7%). Two occlusions were found; one resulted in death, the other was asymptomatic 2/27 (7.4%). Clinical follow up ranged from 3-41 months, with mean of 17.6 months. One stroke was found in the vascular territory after 30 days 1/27 (3.7%). In wingspan arm:

two patients had subarachnoid hemorrhage 2/44 (4.4%), seven minor (nondisabling) and one major ischemic stroke within the vascular territory within 30 days 8/44 (18.1%). For a total of 22.5% of acute complications, none were fatal. Thirty-four of 44 patients had angiographic follow up (29 catheter angiograms, 2 MRA, 3 CTA). Two of 34 had total occlusion (5.8%), four needed instant angioplasty 4/34 (11.76%). Thirty-four patients had clinical follow up within 2.5-26 months, with a mean of 6.7 months. One stroke occurred more than 30 days later, with its location in the vascular territory 1/34 (2.9%).

CONCLUSION
Balloon-mounted stent group had fewer complications and lower restenosis rate in comparison to wingspan patient population. We think this data should be considered when trials for intracranial stenting are designed. Although angioplasty carries fewer risks up front, it has a very significant restenosis/occlusion rate.

KEY WORDS: Intracranial stenosis, stroke, stenting

Paper 306 Starting at 4:27 PM, Ending at 4:35 PM
Assessment of Cerebrovascular Reserve Using Dynamic CT Perfusion with Acetazolamide Challenge Test in Unilateral Middle Cerebral Artery Steno-Occlusive Disease

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PURPOSE
Dynamic CT perfusion with acetazolamide (ACZ) challenge (dCTP) is a safe, noninvasive and easily available method to evaluate cerebrovascular reserve (CVR) in patients with symptomatic unilateral middle cerebral artery (MCA) steno-occlusive disease. The purpose of our study was to quantify CVR using dCTP, to correlate derangement of the CVR with the severity of clinical presentation and angiographic imaging and to determine the value of dCTP in providing complimentary information which may aid in clinical management.

MATERIALS & METHODS
Retrospective review of the clinical charts of all consecutive patients who underwent perfusion CT imaging before and after ACZ challenge for symptomatic M1 disease identified 12 patients with unilateral MCA stenosis or occlusion. MR imaging, MR angiography (MRA) and conventional angiography (DSA) images were reviewed. Dynamic CT perfusion was performed using a standard technique and functional maps were calculated. Cerebral blood flow (CBF), cerebral blood volume (CBV) and mean transit time (MTT) were calculated in the MCA territories bilaterally by manually drawing regions of interest (ROIs) to avoid areas of infarction and cortical blood vessels and the percent change for CBF and MTT was calculated using the formula: rParameter (%) = (parameter post ACZ - parameter pre ACZ)/parameter pre ACZ x 100. Besides medical management with antiplatelet medications and statins, one patient underwent angioplasty and four patients were treated with endovascular stent placement.
RESULTS
CT perfusion preacetazolamide demonstrated decreased CBF and prolonged MTT in the diseased MCA territory. Deranged CVR was demonstrated as a decrease in the rCBF and increase in rMTT. Derangement of the CVR was classified as mild (n = 2) with 10-30% increase in CBF, moderate (n = 5), with 0-10% rCBF and severe (n = 5) with negative rCBF (steal phenomenon). Mild CVR derangement was associated with a single episode of TIA and good collateral flow on DSA. Patients with moderate and severe derangement had progressive decline in superior cortical functions and repetitive deficits in the affected MCA territory. Two out of five patients with steal phenomenon presented with postural worsening of the deficits. The degree of stenosis or occlusion did not correlate with the CVR derangement. Absent collateral circulation by DSA was seen in patients with severe CVR derangement. Endovascular management performed in three of five patients with severe derangement and in two of five patients with moderate derangement with significant clinical improvement along with restoration of the CVR on follow-up dCTP in three patients.

CONCLUSION
Dynamic CT perfusion is a valuable method for evaluation and stratification of CVR in MCA territory hypoperfusion with good correlation with the clinical presentation and can be used as an adjunct for treatment selection.

KEY WORDS: Middle cerebral artery stenosis, CT perfusion, middle cerebral artery occlusion

Paper 307 Starting at 4:35 PM, Ending at 4:43 PM
Neurovascular Compression and Oculomotor Nerve Palsy: A New Role for CISS Imaging
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PURPOSE
While neurovascular compression (NVC) has been proposed as a mechanism for isolated cranial neuropathies, such as trigeminal neuralgia and tinnitus, conventional MRI/MRA spatial resolution is often inadequate to demonstrate focal structural causes for oculomotor (CN III) palsy. In this study, we propose that high-resolution 3D constructive interference steady state (3D CISS) imaging can be instrumental in the detection of vascular compression.

MATERIALS & METHODS
Under IRB approval, a retrospective analysis of four patients with isolated unilateral CN III was performed. Conventional MR imaging including thin section axial and coronal T2 imaging was performed. In addition, axial or coronal CISS imaging was performed through the midbrain and pons. 3 T CISS imaging parameters were: TR 5.96 ms, TE 2.95 ms, FOV 150 mm, matrix 256 x 256, FOV phase 87.5%, flip angle 37 degree, slice thickness 0.6 mm. 1.5 T CISS imaging parameters were: TR 6.73 ms, TE 3.37, FOV 120 x 100 mm, matrix 256 x 256, FOV phase 100%, flip angle 70 degree, and slice thickness 0.5 mm. Postprocessing was performed on a 3D workstation (Wizard/Leonardo Workstation, Siemens Medical Imaging). Maximum intensity projections, multiplanar reformation, minimum intensity projections, and volume rendered images were generated.

RESULTS
In three of four patients with isolated unilateral CN III palsies, CISS imaging demonstrated neurovascular compression not fully resolved on conventional MR imaging sequences. In one patient, a fetal origin PCA with prominent ectatic posterior communicating artery exhibited mass effect upon the cisternal segment of CN III. In second patient, a dolichoectatic basilar, P1 segment, and SCA surrounded and displaced CN III. In a third patient, a dolichoectatic PCOM abutted the CN III without definite displacement. Volumetric renderings demonstrate the 3D relationships of CN III and vascular structures.

Figure. Axial 3D CISS image demonstrating PCOM “bow-stringing” CN III as it extends from interpeduncular to oculomotor cistern in patient with isolated right CN III palsy.

CONCLUSION
When neurovascular compression of cranial nerves is suspected, 3D CISS imaging provides invaluable tool for elucidating complex anatomical relationships.

KEY WORDS: Cranial nerve palsy, oculomotor, CISS imaging

Paper 308 Starting at 4:43 PM, Ending at 4:48 PM
Complex Superior Sagittal Sinus Dural Arteriovenous Fistula Treated with Onyx: Case Report
Supsupin, E. P. · Illoh, K. · Tandon, N. · Vollmer, D. · Grotta, J. · Cacayorin, E. D.
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PURPOSE
We aim to draw attention to evolvement of a preponderantly white matter localized hemorrhage as a sequela of venous hypertension of a dural arteriovenous fistula (AVF) of the
superior sagittal sinus (SSS) that unusually drained into white matter or medullary veins and which was treated effectively with Onyx. Instead of the commonly encountered cortical or superficial location of bleed in a complex dural AVF, the white matter distribution of hemorrhage generated complexity in terms of diagnosis and management in our patient with a history of breast carcinoma. MR imaging and cerebral angiogram implicated ruptured enlarged “medullary vein(s)” in association with venous hypertension from a SSS dural AVF. The malformation was treated successfully with Onyx with subsequent resolution of hemorrhage and decompression of dilated “medullary veins” In our extensive literature search, we failed to find any case report similar to ours.

**Case Report**
A 49-year-old male with a history of breast carcinoma and who had been treated previously with chemotherapy was referred to our institution. He had been managed for intermittent seizures for the past 2 months prior to admission. At that time, CT failed to demonstrate any ischemic or edematous changes or intracranial mass. The patient had headaches, but with no visual symptoms, tinnitus, or neurologic deficits. Two months later, he again presented with seizures and at this time, CT showed hemorrhage. Based on history, the initial diagnosis was metastatic breast carcinoma.

**Imaging Findings**
CT demonstrated a right parietal hematoma which was localized by subsequent MRI to be preponderantly white matter in distribution. Enhancing curvilinear vessels intrinsic and adjacent to the hemorrhage (figure) were delineated. Focal and/or peripherally enhancing lesion as would be anticipated with metastasis was not shown; however, this remained the predominant concern given the patient’s history. With the enhancement pattern, leptomeningeal disease was considered additionally. Arteriovenous malformation was not favored as no arterial feeders, nidus, or enlarged draining veins were detected. MR angiography and venography were performed which was interpreted as sagittal venous sinus thrombosis and hemorrhagic venous infarct. Cerebral angiogram demonstrated a dural AVF of the SSS with dilated cortical veins and markedly dilated medullary veins mostly in the region of the hematoma.

**Summary**
Dural AVF of the SSS can be associated with white matter hematoma as a sequela to venous hypertension and rupture of medullary vein(s) which has not been described previously. This added complexity in our case with a history of breast carcinoma.

**Key Words:** Dural AVF, arteriovenous malformation, metastasis

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**Wednesday Afternoon**

3:15 PM – 4:45 PM
Room 208/209

(45c) SPINE: Degenerative, Inflammatory Infectious, Demyelinating Diseases/Excerpta (Scientific Papers 309 – 320)

See also Parallel Sessions
(45a) Socioeconomics & Anatomy
(45b) ADULT BRAIN: Vascular, Intracranial
(45d) INTERVENTIONAL: New Techniques and Devices

Moderators: Zoran Rumboldt, MD
Ayak Wakhloo, MD, PhD
Hypophosphatemia Associated with Monthly Triple-Dose Gadolinium in Patients with Early Forms of Multiple Sclerosis: Data from the BECOME Trial

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Newark, NJ

PURPOSE
The “BECOME” trial, [Betaseron® vs. Copaxone® in multiple sclerosis with triple-dose Gadolinium (Gd) and 3 Tesla MRI Endpoints] is the first head-to-head trial of these FDA approved medications. Because of its proven efficacy in evaluating MS by increasing conspicuity of contrast enhancement, triple-dose Gd (0.3 mmol/kg or 3-dose) gadopentetate dimeglumine (Magnevist®, Bayer Healthcare) was 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). Previously reported safety data have consisted of a satisfactory clinical adverse event profile and an increased frequency of hypophosphatemia (hypophos) from pre-Gd values. This communication reports on whether or not this increased frequency of hypophos progressively increases with multiple 3-dose exposures.

MATERIALS & METHODS
To monitor safety, all subjects enrolled in the BECOME study underwent monthly blood and urine examination of 47 specific biochemical parameters (including serum phosphate) prior to each 3-dose MRI. Subjects also underwent clinical monitoring. The percentage of abnormal laboratory values while undergoing monthly 3-dose Gd was compared to the pre-3-dose Gd percentage. To control for biochemical abnormalities caused by Betaseron and Copaxone, the results were stratified by treatment group. Since the frequency of hypophosphatemia was noted to increase once on 3-dose over the pre-Gd values, the frequency among all cases with at least one abnormal phosphate value was studied as a function of the cumulative number of 3-doses exposures. Cases of hyperphosphatemia were analyzed in two ways, once as an episode of “hypophos” (i.e., normal phosphate) prior to each 3-dose MRI. Subjects also underwent specific biochemical parameters (including serum phosphate) prior to each 3-dose MRI. Subjects also underwent clinical monitoring. The percentage of abnormal laboratory values while undergoing monthly 3-dose Gd was compared to the pre-3-dose Gd percentage. To control for biochemical abnormalities caused by Betaseron and Copaxone, the results were stratified by treatment group. Since the frequency of hypophosphatemia was noted to increase once on 3-dose over the pre-Gd values, the frequency among all cases with at least one abnormal phosphate value was studied as a function of the cumulative number of 3-doses exposures. Cases of hyperphosphatemia were analyzed in two ways, once as an episode of “nonhypophosphatemia” (i.e., normal with respect to hypophos) and once as an episode of “abnormal phosphate level”. A logistic model with GEE was utilized for statistical analysis.

RESULTS
The vast majority of 47 tests did not show any greater frequency of abnormalities after starting triple-dosing than at the pre-Gd visit (visit 1). An exception was low serum phosphate, observed significantly more frequently on monthly 3-dose, (from 3% to 15%, p<0.05) with no significant difference between treatment groups. Of the 75 subjects, 44 subjects had at least one episode of hypophos. In this subgroup, the frequency of hypophos was 5% at visit 1, (the pre-Gd visit); an average of 11% at visit 1, (the pre-Gd visit); an average of 11% during visits 2 to 4, and an average of 31% during visits 5 to 15. The trend to increase the frequency of hypophos with increased number of exposures was found to be significant, (p<.001). There were no incidents of severe (<1mg/dL) hypophosphatemia.

CONCLUSION
Serial administration of 3-dose gadolinium may be associated with an increased incidence of hypophosphatemia, which appears to be related to cumulative dose. It is speculated that this could be the result of free Gd accumulation over multiple exposures.

KEY WORDS: Gadolinium, toxicity, MS

Do Annular Tears Precede the Appearance of Disk Herniations?

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St. Louis, MO

PURPOSE
To study the signal intensity of peripheral annulus in intervertebral disks that later develop disk herniations.

MATERIALS & METHODS
Forty-six patients, who had undergone more than one MR scan of the lumbar spine, were identified from our radiology database. Patients with fractures, infection, or surgical intervention performed during the interval between the two studies were excluded. The MR studies were presented in a blinded fashion to two neuroradiologists, who evaluated intervertebral disks between T12 through S1 levels for presence of annular tears, manifested by presence of high intensity zone (HIZ) in the annulus, and for presence of any disk herniations. The conspicuity of the annular tears was graded on a scale of 1 (HIZ with signal intensity matching that of CSF) through 4 (subtle intermediate signal within the peripheral annulus). From the collected data, the disks with new herniations on the follow-up study were identified. Both MR examinations of these disks then were evaluated together to correlate the location of the new disk herniation with that of HIZ on the initial examination.

RESULTS
The study included 14 males and 32 females, with age ranging from 20 years to 88 years. Mean interval between the studies was 32 months, ranging from 5 months to 69 months. Two hundred three (73.5%) disks demonstrated annular tears on the initial MR examination, 60% of which were considered grade 3 in conspicuity. Disk herniations were noted in 37 (13.4%) disks on the initial examination. A total of seven new disk herniations were identified on the follow-up studies, all developing in the disks noted to have annular tears on the initial study. Six of seven (85.7%) of the new herniations appeared at a location concordant with the location of the annular tear on the original study. One new disk herniation was noted at the site where initial study obtained 42 months earlier had demonstrated normal signal intensity of the annulus in the corresponding location.
**CONCLUSION**
High intensity zones suggestive of annular tears often precede the appearance of disk herniations.

**KEY WORDS:** Annular tear, disk herniation

**Paper 311 Starting at 3:31 PM, Ending at 3:39 PM**
MR Imaging Associations with a Positive Lumbar Diskogram: A Study of 736 Patients

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**PURPOSE**
To test MRI findings for associations with a provocative lumbar diskogram.

**MATERIALS & METHODS**
Lumbar spine diskogram clinical records and prediskogram MRIs of 736 patients (2457 disks) were reviewed retrospectively. Each disk level was evaluated for the presence of annular tear, Modic Type 1 change, disk herniation (protrusion or extrusion), and spondylolisthesis. The clinical record was reviewed for characteristic pain provocation during the diskogram.

**RESULTS**
All the following associations with a provocative diskogram were statistically significant to a p value of 0.0001 or less. Annular tear (sensitivity 0.25, specificity 0.95). Modic Type 1 (sensitivity 0.15, specificity 0.98). Herniation (sensitivity 0.28, specificity 0.96). Spondylolisthesis (sensitivity 0.14, specificity 0.96). The combined sensitivity and specificity of these MRI variables in predicting a positive diskogram was 0.74 and 0.86 respectively.

**CONCLUSION**
Annular tears, Modic Type 1 end plates, disk herniations and spondylolisthesis are significant lumbar pain generators to a high degree of confidence.

**KEY WORDS:** Diskogram, MRI

**Paper 312 Starting at 3:39 PM, Ending at 3:47 PM**
1H-MR Spectroscopy in the Evaluation of Normal and Pathologic Spines

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**PURPOSE**
This report focuses on proton MR spectroscopy (1H MRS) in the evaluation of different vertebral bone, ranging from normal bone marrow and its variations in aging, to primary or secondary pathologies. The detection and recognition of internal molecular variations in the spongious vertebral bodies can be utilized to distinguish the different sources of bone pathology. MR spectroscopy allows an accurate separation of water and fat signals, assessment of relative quantities, and subsequently the determination of line widths and relaxation times. The relative water intensity has been shown to correlate with the cellularity of hematopoietic elements and is the dominating tissue in youth. Instead the relative proportion of fat cells in red marrow is low at birth and increases with age resulting in a conversion of red marrow to yellow marrow with fat cells as the dominating tissue.

**MATERIALS & METHODS**
The study was performed with a 3 T MR unit (Achieva, Philips); we used a single voxel (SV) method (TR/TE 2000/40 msec) with point-resolved spectroscopy sequence (PRESS). We measured % FF and lipid/water ratio (LWR) in 85 subjects with MR findings of weakened bone, including osteoporosis, vertebral collapse, multiple myeloma, metastasis. The control group consisted of 65 subjects with no spinal pathologies.

**RESULTS**
In accordance with the relative presence of fat and water within the vertebral body, and their changes connected to age, we found that in severe osteoporotic vertebrae and in hematopoietic diseases an inversion of physiologic LWR is present. This is probably due to intraspongious edema at high risk levels for vertebral collapses, and to increased cellularity connected to infiltration of malignant cells originating from the hematopoietic system with replacement of lipid-containing cells.

**CONCLUSION**
Proton MR spectroscopy provides a fine evaluation of vertebral bone marrow changes due to primary or secondary pathologies and allows appreciated differences not easily assessable with conventional imaging. In the upcoming future, MR spectroscopy may be powerful in identifying physiologic as well as pathologic biochemical changes in vertebral bone.

**KEY WORDS:** Spine, spectroscopy, fracture

**Paper 313 Starting at 3:47 PM, Ending at 3:55 PM**
MR Spectroscopy of the Cervical Spine in Patients with Spondylosis

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**PURPOSE**
MR spectroscopy (MRS) has been utilized in diverse clinical situations to improve evaluation of entities such as tumors, infection, stroke, trauma and metabolic disorders. While the use of MRS has been studied widely in the brain, less is known regarding their application in the spine. Cervical spondylosis is a common disease whose incidence increases with age. The degenerative condition, and its surgical treatment, is associated with significant morbidity and mortality. Optimal timing of decompressive surgery currently is based upon radiographic changes of myelomalacia or severe clinical symptomatology. The purpose of the study is to demonstrate the MRS spectrum pattern of the cervical cord in patients with spondylosis referred to neurosurgery for evaluation.
Materials & Methods
Twenty patients (mean age 51) with cervical spondylosis for preoperative evaluation were studied. An MRI scan is performed on a Siemens Sonata 1.5 T scanner utilizing T1- and T2-weighted axial and sagittal images. Pulse oximeter triggering is employed in both MRS sequences to reduce artifact from the movement of the spinal cord and CSF pulsation. A single voxel measuring 0.6-1 x 0.6-1 x 1-2 cm (AP x TR x CC) is placed at the C2-3 spinal cord level for MRS. More inferior placement of the voxel is limited due to the size of the cord. A short-echo point-resolved spectroscopy (PRESS) sequence TE = 30 ms, TR = 1500/3000, 256 averages, acquisition time 3-6 minutes. Choline/Cr and NAA/Cr ratios were obtained.

Results
Choline/Cr ratio is within normal limits. NAA/Cr ratio was decreased significantly (0.58 to 0.74). Some patients showed high lactate peak. The degree of spinal canal narrowing and presence of T2-weighted high intensity in the cord was correlated with presence of lactate peak.

Conclusion
MR spectroscopy showed decreased NAA in the normal-appearing C2-3 level spinal cord in the symptomatic cervical spondylosis patients. This technique will have a promising future application for the different disease in the spinal cord including demyelinating disease or vascular pathology.

Key Words: Cervical spondylosis, MR spectroscopy, myelomalacia

Paper 314 Starting at 3:55 PM, Ending at 4:03 PM
Anterior Atlantoaxial Subluxation: A Further Look in Neutral Position MR Imaging

Hung, S.1 · Wu, H.2 · Guo, W.3
1Chang-Gung Memorial Hospital, Linkou, Taoyuan, TAIWAN, 2Taipei Veterans General Hospital, Taipei, TAIWAN

Purpose
Functional x-ray cervical radiography, including flexion and extension views, is the gold standard screening imaging for anterior atlantoaxial subluxation (AAS). Atlantodental interval (ADI) measured on the radiograms provide imaging evidences for the diagnosis. In routine MR practice, patients are in supine and neutral positioning during scanning and the functionality of atlantoaxial joint is not feasible to evaluate. It was hypothesized that MR imaging provide three-dimensional information and soft tissue contrast that were lacking in x-ray radiography and therefore might improve the imaging diagnosis of AAS. The current study was conducted to evaluate the suggestive imaging signs of AAS on neutral position MR and compare those signs between stable and unstable AAS.

Materials & Methods
Forty patients with AAS diagnosed by functional cervical radiography between 2004 and 2007 and 20 AAS negative patients (as a control group) were recruited. Cervical spine MR images of these cohorts were obtained on 1.5 T scanners with neutral positioning. Sagittal view with T1-weighted, T2-weighted and proton-weighted pulse sequences were the standard imaging protocol for these patients. On the MR images, ADI, congruity of anterior C1-2 joint and lateral facet joints, continuity of spinolaminar line, and focal spinal cord signal change (if existed) were reviewed and recorded. They served as the parameters for checking the diagnostic sensitivity and specificity of MR signs for AAS. Inter-group comparison between AAS presenting with normal ADI and control group, and between stable and unstable AAS was conducted for evaluating the diagnostic power of these signs. Chi-square test and Fisher’s exact probability test were used for the statistics.

Results
Sixty-five percent (26 of 40) of AAS patients demonstrated abnormal ADI (> 3 mm) and the other 35% with normal ADI on MR imaging. Their statistics of MR signs were summarized in the Table. No significant difference of the imaging signs was found between stable and unstable AAS except focal cord signal changes (sensitivity 55.2%, specificity 81.8%).

Table. Sensitivity and specificity of MR signs for AAS.

<table>
<thead>
<tr>
<th>Imaging signs</th>
<th>Anterior offsetting</th>
<th>Arthropathy</th>
<th>Spinolaminar line disruption</th>
<th>Dens erosion, peridental fluid, anterior tilted C1-2 joint, focal cord signal changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient with AAS vs. Control Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity (%)</td>
<td>75*</td>
<td>68*</td>
<td>75*</td>
<td>45-58*</td>
</tr>
<tr>
<td>Specificity (%)</td>
<td>80*</td>
<td>&gt;=90*</td>
<td>100*</td>
<td>&gt;=90*</td>
</tr>
<tr>
<td>AAS with normal ADI vs. Control Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity (%)</td>
<td>47*</td>
<td>53*</td>
<td>47*</td>
<td>33-53*</td>
</tr>
<tr>
<td>Specificity (%)</td>
<td>80*</td>
<td>90*</td>
<td>100*</td>
<td>&gt;=90*</td>
</tr>
</tbody>
</table>

* p<0.05

Conclusion
In clinical MR practice, using ADI as the only criteria for AAS diagnosis will underestimate the presence of this potentially catastrophic disease. Reading MR imaging of C1-2 complex unit with caution and pay special attention to lateral facet joints, anterior C1-2 joint and spinolaminar line definitively will improve the imaging diagnostic of AAS.

Key Words: Atlantoaxial subluxation, instability, MRI

Paper 315 Starting at 4:03 PM, Ending at 4:11 PM
Perfusion CT Measurements in Cervical Spinal Cord: Feasibility and Reproducibility of the Study as Well as Interchangeability of the Measurements Using Two Commercially Available Software Packages

Bisdas, S.1 · Rumboldt, Z.1 · Surlan, K.1 · Deveikis, J.1 · Spampinato, M.1
1Medical University of South Carolina, Charleston, SC, 2Clinical Centre Ljubljana, Ljubljana, SLOVENIA

Purpose
To examine the feasibility of in vivo perfusion CT studies of the cervical spinal cord, to examine the reproducibility of the technique as well as the interchangeability of the values obtained by two different commercially available post-processing software packages. An additional objective was to examine any significant age-related changes of the spinal cord perfusion.

Materials & Methods
Perfusion CT studies of 40 patients (23 male, 17 female, median age 55 years, range 16-84 years) with primary tumors in the extracranial head and neck were identified ret-
Comparison of Axial MR Sequences for the Detection of Multiple Sclerosis Lesions in the Cervical Spinal Cord at 3 T

Ozturk, A.¹ · Aygun, N.¹ · Smith, S. A.¹ · Caffo, B. S.² · Calabresi, P. A.¹ · Reich, D. S.¹
¹The Johns Hopkins Medical Institutions, Baltimore, MD, ²The Johns Hopkins University School of Public Health, Baltimore, MD, ³The Johns Hopkins University School of Medicine, Baltimore, MD

**Purpose**

In multiple sclerosis (MS), spinal cord MR imaging can be useful for both establishing early diagnosis and recognizing clinical subtypes of MS. Short-tau inversion recovery (STIR) has been demonstrated to be the most sensitive sagittal pulse sequence for imaging cervical cord lesions in MS. The purpose of this study is retrospectively to compare axial T2-weighted fast spin-echo (FSE), T2*-weighted gradient recalled echo (GRE), and magnetization transfer-prepared T2*-weighted GRE (MT-GRE) pulse sequences to determine the best axial sequence to use in concert with the sagittal STIR images.

**Materials & Methods**

T2-weighted FSE, GRE, MT-GRE, and STIR images were obtained in 63 MS patients and 19 healthy controls with a 3 T MR system. Gradient recalled echo sequences were 3D acquisitions performed with and without radiofrequency irradiation (24ms duration, 8.5uT amplitude, sinc-shaped pulse at 1.5kHz off-resonance with respect to water) and were acquired using a multishot EPI readout with TR/TE/flip = 118ms/15ms/12deg and SENSE factor = 2.0. Nominal resolution was 0.69mm in-plane with a 220mm FOV. Two coils were used in this study: a 2 element phased-array surface coil and a 16-channel phased-array neurovascular coil covering the head and neck. Cord lesions seen on images obtained with each sequence were evaluated blindly by two observers. Presentation order was randomized across sequence type and subject. Axial series were displayed on a workstation, juxtaposed against the sagittal STIR images for the same subject. The observers initially viewed the images separately and subsequently came to an agreement about the presence and location of lesions. Overall image quality, as well as the presence of atrophy, swelling, and diffuse signal abnormality, were evaluated also.

**Results**

There was no significant effect of technique on scan quality (Kruskal-Wallis test, p=0.9). There was a significant effect of sequence type on lesion volume in MS patients (Kruskal-Wallis test, p=0.0003). The volume of lesions detected on both GRE (Wilcoxon sign-rank test, p=0.014) and MT-GRE (p<0.0001) was higher than on T2-weighted FSE. There was a trend toward significantly higher lesion volume in GRE compared to MT-GRE (p=0.06). Although 3% to 11% of MS patients had atrophy or diffuse signal abnormality on some of the sequences, these percentages were not significantly higher than among controls, and there was no significant effect of sequence type on whether such findings could be detected.

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**RESULTS**

The medians of BF, BV, MTT, PS, and tp parameters obtained with the Software 1 with AIF in the ICA as well as AIF in the VA were 6.02, 1.00, 14.72, 1.03, 4.5 and 6.87, 1.11, 15.41, 0.9, 5 respectively. Blood volume and MTT values revealed statistically significant differences between the two AIFs (p-value≥0.03). With the Software 2 the BF and BV values were different between the two AIFs (p-value=0.02). The κ coefficients were 0.95-1.00. There was no statistically significant correlation between age and perfusion values. Interobserver agreement was calculated using κ coefficients. Measurement reproducibility and interchangeability of the results were assessed using the Bland-Altman (BA) method. Measurement error and repeatability were assessed also for each of the four perfusion parameters.

**Conclusion**

Deconvolution-based analysis with ATH approach and maximum slope model with Patlak analysis can yield perfusion estimates in the cervical spinal cord with satisfactory reproducibility. The perfusion values are dependent on the AIF site. Only BF and PS values are interchangeable.

**Key Words:** PET-CT, perfusion CT
CONCLUSION
These results demonstrate that axial GRE sequences improve MS lesion detection over T2-weighted FSE in the spinal cord at 3 T. This information is important for diagnosing MS, understanding disease evolution, initiating treatment, and follow up. Although both GRE sequences detect similar lesion volumes, MT-GRE also can provide quantitative information that can be used to follow lesions over time. Thus, we advocate its use in the clinical scenario over T2-weighted FSE.

KEY WORDS: Multiple sclerosis, spinal cord, MRI

Paper 317 Starting at 4:19 PM, Ending at 4:27 PM
Spinal Dural Arteriovenous Fistulas Presenting without Elevated Spinal Cord T-2 Signal
Luetmer, P. H. · Gilbertson, J. R. · Lane, J. I.
Mayo Clinic Rochester, MN

PURPOSE
The detection and localization of spinal dural arteriovenous fistulas (SDAVF) remains a diagnostic challenge and the diagnosis often is delayed for months to years from symptom onset. The classic MRI findings include increased signal within the spinal cord on T2-weighted images, mild cord enlargement, parenchymal gadolinium enhancement, and enhancement and flow voids within tortuous vessels along the dorsal surface of the cord. Increased T2 signal was reported by Gilbertson to be present in all cases in a review of the Mayo experience from 1985 to 1994 (1). The absence of T-2 signal on spinal MRI has been used to exclude SDAVF and avoid catheter angiography. However, increased clinical awareness and recent advances in spinal MRA (2) have improved detection and localization. The purpose of this paper is to report the frequency with which SDAVF was diagnosed in the absence of elevated T-2 signal since beginning routine evaluation of SDAVF with spinal MRA and to assess the average duration of symptom in this patient cohort.

MATERIALS & METHODS
Institutional review board approval was obtained for this study. All involved patients gave informed consent for their participation in this research. Between December 2000 and September 2007, 50 patients had catheter angiographic diagnosis of untreated SDAVF. All patients had undergone clinical evaluation with spinal MRI without and with gadolinium and elliptic centric contrast-enhanced MR angiography prior to catheter angiography using MRI and MRA techniques previously described (2). The MR imaging was reviewed and all features of SDAVF recorded. In all patients with SDAVF without spinal cord T2 signal abnormality, the medical record was reviewed to determine symptom duration, clinical course, and exam at presentation.

RESULTS
Six of 50 patients (12%) with SDAVF had equivocal or no T2 signal abnormality within the spinal cord. In five of these six patients, spinal MRA prospectively identified the SDAVF. Of these five, all had abnormally prominent vessels on postgadolinium T1-weighted images, and 4 had prominent vessels on T2-weighted images. Three of five had faint spinal cord contrast enhancement. One patient had a false negative MRA, but had subtle central lower spinal cord enhancement and mildly prominent vessels on postgadolinium images. Four of six patients had symptom duration of 8 months or less, including one patient who had only two transient episodes of lower extremity weakness, saddle anesthesia and loss of bladder control over a 3-day period prior to diagnosis. The median symptom duration of 8 months in these six patients compares favorably to our previously reported average duration of 27 months (2).

CONCLUSION
Absence of elevated T-2 signal within the spinal cord on MRI does not exclude SDAVF.

REFERENCES

KEY WORDS: Spinal dural arteriovenous fistulas, spinal MRA

Paper 318 Starting at 4:27 PM, Ending at 4:32 PM
Arachnoiditis Ossificans
Schwartz, K. M. · Krecke, K. N.
Mayo Clinic Rochester Rochester, MN

PURPOSE
Present the MRI and CT findings from a case of arachnoiditis ossificans.

CASE REPORT
A 58-year-old man presented with several months of heaviness in his legs, greater on the right, and right lower extremity weakness. His gait was spastic and slightly broad-based, and he had decreased sensation on the left to the T6 level and reduced vibration sense to the knee bilaterally. Sixteen years prior, the patient developed severe occipital headaches. Several lumbar punctures were grossly bloody. Head CT, head and spinal MRI, and two cerebral angiograms were reportedly normal. Recent MRI examination, performed to investigate his subacute myelopathy, prompted referral for evaluation of spinal cord tumor.

IMAGING FINDINGS
An MRI of the thoracic and lumbar spine showed expansion and signal abnormality of the lumbar cord, a syrinx in the lower thoracic cord from T6 to T9 vertebral levels, and multiple extramedullary, intradural masses in the upper thoracic spine similar to CSF signal. Thoracic spine CT showed circumferential arachnoid calcification, most prominent from T5 to T8. Diagnosis of arachnoiditis ossificans, perhaps secondary to old subarachnoid hemorrhage, was made based on imaging findings.
SUMMARY
The patient underwent laminectomy and myelotomy for diagnosis and decompression of the syrinx and extramedullary cyst from T4 thru T6. The dura was opened revealing “scarring around the spinal cord to the very calcified arachnoid space”. Pathology revealed “Arachnoid wall, T5-6, excision: Calcified arachnoid cyst wall.”

REFERENCES

KEY WORDS: Arachnoiditis, ossificans

Paper 319 Starting at 4:32 PM, Ending at 4:37 PM
Imaging Appearance of a Symptomatic Inflammatory Granuloma Associated with an Intrathecal Hydromorphone Pump

Goebel, E. A. · Given, C. A. · Ramsey, C. · Goldstein, S. J.
University of Kentucky
Lexington, KY

PURPOSE
Review the MR and CT appearance of an inflammatory granuloma associated with the tip of an intrathecal Baclofen pump.

CASE REPORT
We will review the imaging findings of a 52-year-old male with history of chronic back pain and “failed back syndrome” receiving intrathecal Dilaudid therapy, who presented with a progressive myelopathy.

IMAGING FINDINGS
MR and CT imaging revealed a ring-enhancing intradural, extramedullary cystic lesion within the midthoracic region, associated with tip of an intrathecal Dilaudid pump/catheter. There was resultant spinal stenosis with accompanying edema within the adjacent spinal cord. The patient underwent a laminectomy and resection/debridement of the granuloma with removal of the distal portions of the catheter.

SUMMARY
While uncommon, granuloma formation can occur with chronic intrathecal administration of medications. Granuloma formation appears to be associated with increased flow rates of medications, and in our case the delivery rate of the Dilaudid medication was deemed excessively high. If patients develop myelopathic or compressive symptoms, then diligence and appropriate imaging with MRI is indicated to evaluate for possible granuloma formation in association with intrathecal catheters.

KEY WORDS: Granuloma, intrathecal, pump

Paper 320 Starting at 4:37 PM, Ending at 4:42 PM
Spinal Epidural Lubricant Grease Collection Mimicking Traumatic Spinal Epidural Hematoma
Kalhins, A.1 · Geryk, B.1 · Olivero, W.2,3 · Kim, T. A.2
1University of Illinois College of Medicine, Urbana, IL, 2Carle Clinic, Urbana, IL

PURPOSE
We report an unusual presentation of a patient with an epidural lubricant grease collection caused by a high-pressure injection injury in an industrial accident that caused radiologic and clinical findings which mimicked an epidural hematoma.

CASE REPORT
The patient is a 31-year-old male who sustained trauma to the right neck and right chest wall while trying to repair a pneumatic device on a hydraulic injection instrument of a bulldozer. During morning rounds on day four of admission, the patient exhibited new neurologic deficits with bilateral leg numbness, tingling, and motor deficits, as well as numbness in his right arm. At surgery, there was a large collection of what appeared to be pus and possibly old blood within the right paraspinal muscles at approximately T2 through T4. Immediately upon opening the ligamentum flavum, more apparent dark epidural fluid was encountered which was thought to represent a collection of pus and old blood. This viscous fluid within the thoracic epidural space was shown to be lubricant grease, with some macrophage infiltration. The lubricant grease was identified as Conoco Phillips DynaLife GC-LB, an automotive lithium complex grease.

IMAGING FINDINGS
On the day of admission, a neck CTA was done, which showed general soft tissue injury, a small residual left pneumothorax, as well as epidural fluid and air collections. MR imaging of the thoracic spine was performed on a Siemens Trio 3 T MRI scanner on day four of admission, revealing a posterior epidural collection with T1 hyperintensity and T2 hypointensity, which was interpreted as an epidural hematoma extending from T1 to T6 levels. A sample of the lubricant grease was placed along with normal saline in a glass jar, and imaged using the same scanner. These images demonstrated identical MRI signal characteristics on T1- and T2-weighted images as those of the epidural fluid collection on the patient’s MRI.
In conclusion, we report an unusual presentation of traumatic spinal cord compression from an epidural grease collection caused by a high-pressure injection injury to the chest and thoracic spine.

**KEY WORDS:** Spinal, epidural, hematoma

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**Wednesday Afternoon**

3:15 PM – 4:45 PM

Room 211/212

(45d) INTERVENTIONAL: New Techniques and Devices
(Scientific Papers 321 – 332)

See also Parallel Sessions
(45a) Socioeconomics & Anatomy
(45b) ADULT BRAIN: Vascular, Intracranial
(45c) SPINE: Degenerative, Inflammatory Infectious, Demyelinating Diseases/Excerpta

Moderators: Jeffrey L. Sushine, MD, PhD

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**Paper 321 Starting at 3:15 PM, Ending at 3:23 PM**

**Use of Intracranial Stents for Treatment of Unclippable and Uncookable Aneurysms**

McKenzie, J. D. · Evans, A. E. · Jensen, M. E.
University of Virginia Health System
Charlottesville, VA

**PURPOSE**

We present the use of 20 intracranial stents for the treatment of nine unclippable and uncookable wide-necked cerebral aneurysms.

**MATERIALS & METHODS**

We treated nine aneurysms in nine patients with 20 stents, ranging in age from 2 to 69 years, using one to four stents in each case. Two patients were male and seven were female. Six were fusiform aneurysms with wide necks, and three were wide-necked blister aneurysms. We used 18 Cordis Enterprise (Miami Lakes, FL) stents and 2 Guidant Chromium-Cobalt (Santa Clara, CA) stents. Aneurysm size ranged from 2 mm to 20 mm. None had any previous treatment. Four aneurysms were in the anterior circulation and five were in the posterior circulation. Four patients presented with subarachnoid hemorrhage, three had other, nonacute, neurologic symptoms, and two were incidental.

**RESULTS**

Nineteen of the 20 stents were deployed without difficulty. One stent could not be deployed fully because the distal tines were contained within a cell of another stent. Internal carotid artery thrombosis occurred in a patient with four stents across a giant cavernous aneurysm with a 9 mm neck. On short-term follow up, four aneurysms had completely resolved, one was smaller, two had stasis of contrast within the aneurysm, one was unchanged, and one had enlarged. This patient had a rehemorrhage. Two patients experienced vasospasm. There was no in-stent stenosis.

**Table 1**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (y)</th>
<th>Sex</th>
<th>Aneurysm Size (mm)</th>
<th>Aneurysm Location</th>
<th>Clinical Presentation</th>
<th>Treatment</th>
<th>Follow-Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65</td>
<td>M</td>
<td>6.0 x 1.0</td>
<td>Right Internal Carotid</td>
<td>Headache</td>
<td>2 Enterprise</td>
<td>Stable on immediate follow up</td>
</tr>
<tr>
<td>2</td>
<td>39</td>
<td>F</td>
<td>2.0 x 3.0</td>
<td>Right Internal Carotid</td>
<td>Subarachnoid Hemorrhage</td>
<td>2 Enterprise</td>
<td>Stable on 2 week follow up</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>M</td>
<td>15.5 x 9.0</td>
<td>Basilar</td>
<td>Myelopathy</td>
<td>3 Enterprise</td>
<td>Thrombosis at 4 months</td>
</tr>
<tr>
<td>4</td>
<td>38</td>
<td>F</td>
<td>18.0 x 1.4</td>
<td>Left Vertebral</td>
<td>Headache</td>
<td>5 Enterprise</td>
<td>Stasis at 3 months</td>
</tr>
<tr>
<td>5</td>
<td>41</td>
<td>F</td>
<td>2.0 x 3.0</td>
<td>Left Internal Carotid</td>
<td>Subarachnoid Hemorrhage</td>
<td>2 Enterprise</td>
<td>Increase size at 2 week follow up</td>
</tr>
<tr>
<td>6</td>
<td>69</td>
<td>F</td>
<td>2.0 x 6.0</td>
<td>Left Internal Carotid</td>
<td>Subarachnoid Hemorrhage</td>
<td>2 Enterprise</td>
<td>Resolved</td>
</tr>
<tr>
<td>7</td>
<td>57</td>
<td>F</td>
<td>20.0 x 17.0</td>
<td>Right Internal Carotid</td>
<td>Cerebral Neuraphy</td>
<td>4 Enterprise</td>
<td>Thrombosis at 6 week follow up</td>
</tr>
<tr>
<td>8</td>
<td>57</td>
<td>F</td>
<td>5.8 x 2.8</td>
<td>Basilar</td>
<td>Subarachnoid Hemorrhage</td>
<td>1 Chromium-Cobalt</td>
<td>Decrease size at 1 month</td>
</tr>
<tr>
<td>9</td>
<td>39</td>
<td>F</td>
<td>2.0 x 8.0</td>
<td>Right Vertebral</td>
<td>Headache</td>
<td>1 Chromium-Cobalt</td>
<td>Resolved at 28 months</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Intracranial stents offer an alternative treatment for cerebral aneurysms that cannot be coiled or clipped.

**KEY WORDS:** Cerebral aneurysm, intracranial stent
Paper 322 Starting at 3:23 PM, Ending at 3:31 PM

Multicenter Prospective Study on Matrix Coils for Unruptured Intracranial Aneurysms Treatment (MURAT study)

Spelle, L.¹ · Pierot, L.² · Bonafe, A.³ · The MURAT study
¹Fondation Rothschild Hospital, Paris, FRANCE, ²Chu Maison Blanche, Reims, FRANCE, ³Gui de Chauliac Hospital, Montpellier, FRANCE

PURPOSE
To precisely evaluate the clinical and anatomical results of the selective endovascular treatment of intracranial aneurysms using Matrix coils.

MATERIALS & METHODS
Matrix coils for unruptured intracranial aneurysms treatment (MURAT) is a prospective, multicenter, consecutive registry conducted from June 2005 to October 2006. One hundred eighty-eight patients harboring 206 unruptured aneurysms were included and treated in 12 centers.

RESULTS
Treatment was achieved in 97% of cases. Total or subtotal angiographic occlusion of the aneurysms was achieved in 81.5% of the cases. Technical complications, with or without clinical consequences, were encountered in 20% of patients, including peroperative perforation (2.6%), thromboembolism (9.6%), devices related complications (5.3%) and others (2.6%). One-month postoperative mortality was 1.59%, respectively. Causes of three deaths were thromboembolic complication leading to intracerebral hemorrhage in one case, peroperative rupture due to balloon inflation in one patient and not related to EVT in one case. One-month postoperative morbidity was 3.2%. Factors affecting morbidity and mortality are analyzed.

CONCLUSION
Matrix coils for unruptured intracranial aneurysms treatment is the first and largest prospective, multicentric study and independently controlled registry that has evaluated Matrix coils in unruptured aneurysms. Morbidity and mortality are low, comparable to bare coils. According to these promising results, the study will continue to evaluate late clinical and angiographic results.

KEY WORDS: Coil, matrix, aneurysm

Paper 323 Starting at 3:31 PM, Ending at 3:36 PM

Cerecyte Coils in the Treatment of Intracranial Aneurysms: Single Center Clinical and Angiographic Midterm Results

Linfante, I. · DeLeo, M. J. · Brooks, C. · Wakhloo, A.
University of Massachusetts Medical School
Worcester, MA

PURPOSE
Recanalization of the aneurysmal sac may occur in up to one third of all patients treated by endovascular embolization with detachable coils. Polymer-coated coils can accelerate aneurysmal scar tissue formation. However, coil friction and compartmentalization secondary to the coating may be the cause of higher recanalization rates compared to bare platinum coils. The Cerecyte Coil System (Micrus Endovascular) is a polymer-loaded coil designed to present less friction and better aneurysmal filling while delivering a bioactive copolymer. In this study, we performed safety and efficacy analysis of Cerecyte coils in the treatment of ruptured and unruptured intracranial aneurysms.

CASE REPORT
In a retrospective database analysis, 184 patients with intracranial aneurysms underwent endovascular coil embolization from July 2005 and September 2007 in our center. Forty-nine patients with 51 aneurysms were treated with Cerecyte coils. Follow-up catheter angiography at 6 and 12 months was available for 23 and 6 patients, respectively. Postcoiling results and subsequent follow-up angiograms were classified using a modified 3 point Raymond Scale.

IMAGING FINDINGS
Patient age ranged from 26-83 years (31 women). Mean aneurysm size was 7.4mm (2mm-25mm) and mean neck size was 4.6mm (2mm-18mm). Nineteen aneurysms were ruptured at presentation. There were 15 small, 5 large, and 2 giant aneurysms. Five were fusiform/dissecting aneurysms and 2 were recurrent aneurysms postmicrosurgical clipping. There were 11 anterior communicating artery or A1/A2 aneurysms (ACA), 11 internal carotid (4 ICA trunk, 2 supraclinoid, 2 ophthalmic, 1 cavernous, 1 terminus, 1 superior hypophyseal), 10 middle cerebral (MCA), 6 basilar tip, 6 posterior communicating (PCOM), 2 posterior inferior cerebellar, 1 superior cerebellar (SCA), 1 pericallosal, 1 vertebral, and 1 posterior cerebral artery aneurysms. Balloon-assisted coil embolization was performed in nine patients and stent-assisted coil embolization was carried out in nine patients. Initial complete occlusion of the aneurysm (Raymond scale grade 1) was accomplished in 43 patients (88%), small residual neck (grade 2) was seen in six patients (12%), and no patients were grade 3. The grade 2 aneurysms were located in the following vessels: ICA (2), ophthalmic, ACA, MCA, and SCA. Two patients had intraprocedural aneurysm rupture, with no long-lasting sequelae. Six patients had intraprocedural clot on coil formation that was treated successfully with intraarterial abciximab infusion. One patient of these six developed a small cerebral infarct. Follow-up angiography at 6 months revealed two cases of small recanalization of the neck. Both patients were grade 2 following intervention. One was an SCA aneurysm that recurred postmicrosurgical clipping and the other was a PCOM aneurysm. So far, there have been no cases of aneurysmal recanalization at 12 month follow up. There was one death in the follow-up period from unrelated causes. No hemorrhages were noted in the follow-up period and no retreatment has been needed so far.

SUMMARY
Cerecyte coils have a satisfactory safety profile. In particular, they seem to present less friction and compartmentalization compared to the previous generation of bioactive coils.

KEY WORDS: Intracranial aneurysm, Cerecyte coil
Penumbra Stroke Trial: Effects of Revascularization on the Middle Cerebral Artery in High Risk Patients with Acute Ischemic Stroke

Madison, M. T.

for the Penumbra Stroke Trial Investigators, St. Paul Radiology and Health East Neurovascular Institute Saint Paul, MN

PURPOSE
The Penumbra System™ is a new generation of mechanical devices designed to reduce clot burden in acute stroke due to large vessel occlusion. It comprises of multiple device platforms that may be selected by the operator determined by the nature of the thrombotic occlusion and the angio-architecture of the target vessel. Reported herein are results from a subgroup analysis from a recently completed clinical trial on the effects of revascularization in the middle cerebral artery (MCA).

MATERIALS & METHODS
A total of 125 patients were enrolled in this prospective, single arm, multicenter international trial. Main entry criteria were NIH Stroke Scale (NIHSS) score > 8, presentation within 8 hours of symptom onset, and an occlusion (TIMI 0 or 1) of a treatable intracranial vessel. Patients who presented within 3 hours from symptom onset must have been ineligible for or refractory to rtPA therapy. Primary endpoints were revascularization of the target vessel (TIMI 2 or 3) and incidence of procedural serious adverse events (SAE). Angiographic results were adjudicated by an independent Core Laboratory.

RESULTS
A total of 125 target vessels were treated by the Penumbra System: internal carotid artery (23), MCA (87), vertebral-basilar arteries (11), posterior cerebral artery (3) and anterior cerebral artery (1). Mean baseline values at enrollment were: age 64 years, NIHSS score 17.6 (range 8 to 34), mRS 4.5. All target vessels had TIMI scores of 0 or 1 at the site of primary occlusion prior to treatment. After the use of the Penumbra System, 82% of all treated vessels were revascularized to TIMI 2 or 3 with a procedural SAE rate of 3.2%. The MCA revascularization rate was 82.8% (72/87) and compared favorably with the 18% spontaneous revascularization rate of the placebo arm in PROACT II (1). Results were untreated, serving as controls against self-thrombosis. Among treated aneurysms, the stent covered the neck partially in five and entirely in seven. Animals were placed on daily aspirin (8mg/kg by mouth) following aneurysm creation. After 4 weeks, a final angiogram was performed, and aneurysm specimens were explanted. Angiograms acquired before and after treatment and at 4-weeks follow-up were analyzed both qualitatively and quantitatively using normalized time-density curves (NTDC). Cone-beam micro-CT and histologic specimen analysis then was performed.

RESULTS
Normalized time-density curves analysis showed drastic contrast material reduction in the aneurysm dome following stent placement. After treatment, the NTDC peaks dropped on average by 45% of the initial values for partially covered aneurysms and 78% for fully covered aneurysms. Cone-beam micro-CT imaging performed at 4 weeks posttreatment showed partial thrombosis in four of five partially covered aneurysms and complete thrombosis in all fully covered aneurysms. Histologic evaluation revealed neointima coverage of all asymmetric patch regions. Aneurysm dome thrombus was observed in fully covered and partially covered aneurysms as well. One dog with four aneurysms (2 controls,
2 treated) expired due to groin hemorrhage and did not undergo 4-week follow-up analysis, and one carotid artery in another animal (1 aneurysm) was occluded at the 4-week follow-up.

**CONCLUSION**

We demonstrate aneurysmal blood flow diversion using a new low porosity patch containing asymmetric vascular stent in a canine sidewall aneurysm model. Overall results are encouraging and support continued AVS development.

**KEY WORDS:** Stent, aneurysm, canine model

**Paper 326 Starting at 3:52 PM, Ending at 4:00 PM**

Reversal of Flow within the Internal Carotid Artery for Carotid Stenting

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1 University at Buffalo, Buffalo, NY, 2 University of Minnesota, Minneapolis, MN

**PURPOSE**

With advancing endovascular techniques, carotid stenting is being performed with increasing frequency. Despite the use of distal protection devices, migration of embolic material remains a dreaded complication, especially for cases with severe stenosis or intraluminal thrombus. In this series, we report the early United States experience on the feasibility and safety of internal carotid artery flow reversal to provide embolic protection.

**MATERIALS & METHODS**

Carotid stent placement was attempted using flow reversal [the Gore Neuroprotective System (1)] on seven patients (4 women, 3 men). Mean age was 75.4 ± 8.1 years, and the average stenosis was 83 ± 12%. Two patients had symptomatic carotid stenosis; five had no symptoms. All patients were deemed high risk for other techniques of embolic protection.

In addition to standard monitoring for angioplasty and stenting, all cases were performed while the patients were awake for close monitoring with serial neurologic examinations.

**RESULTS**

Carotid stenting was achieved successfully in six patients using reversal of flow. In the seventh case, the flow-reversal technique was not used because of difficult anatomy (instead, distal filter protection was utilized). There were no complications, and all patients remained at their neurologic baseline condition.

**CONCLUSION**

In our experience and that of others outside the United States (2, 3), internal carotid artery flow reversal is a safe method for embolic protection and can be performed with excellent clinical outcomes. Selection of cases with favorable anatomy prevents technical limitations and potential complications.

**REFERENCES**


**KEY WORDS:** Carotid stenting, flow reversal, angioplasty

**Paper 327 Starting at 4:00 PM, Ending at 4:08 PM**


Diaz, O.; Nasseri, F.; Klucznik, R.

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Houston, TX

**PURPOSE**

The value of hypervascular tumor embolization is well documented in the literature. However, the efficacy and feasibility of Onyx (ethylene vinyl alcohol copolymer- Onyx: Micro Therapeutics, Irvine, California) as a tumoral embolic agent has not been well established. The purpose of our study is to demonstrate our early experience utilizing Onyx for embolization of hypervascular tumors of head and neck, technical aspects and its effect reducing intraoperative blood loss.

**MATERIALS & METHODS**

We retrospectively studied 15 patients (10 females and 5 males, mean age: 53 years, range: 17-71 years), from October 2006 to December 2007, with hypervascular primary and secondary head and neck tumors underwent complete diagnostic angiography and Onyx embolization. Twelve out of 15 patients underwent surgery within 24 hours postembolization. Documented intraoperative blood losses were obtained retrospectively from operative reports. Three patients underwent palliative embolization. The technical aspects, devascularization and postoperative blood loss were evaluated.

**RESULTS**

During Onyx embolization it was noted a homogenous intra- tumoral penetration with progressive slowing blood flow during injection. A total of 31 arterial feeders were embolized with complete devascularization achieved in 10/15 tumors and partial devascularization in 5/15 tumors. In several cases transarterial delivery of Onyx allowed to embolize multiple tumoral feeders from a single vessel approach in an antegrade fashion without selecting different tumoral vascular supply or super-selective catheterization. The estimated intraoperative blood loss in 12 embolized tumors was available from operative reports. The mean intraoperative blood loss in 12 embolized tumors was 751cc (ranged 150cc - 2200cc).

**CONCLUSION**

The use of Onyx for treatment of vascular tumor embolization in head and neck is technically feasible and safe. More clinical and angiographic follow-up data are required for critical assessment of this new treatment modality.

**KEY WORDS:** Embolization, tumors, Onyx
Arterial Embolization with Onyx of Hypervascular Skull Base Tumors

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Toulouse, FRANCE

PURPOSE
To present and evaluate advantages, benefits, and risks of intraarterial embolization of hypervascular skull base tumors with Onyx.

CASE REPORT
Since January 2007, eight patients with an hypervascular skull base tumor underwent intraarterial embolization with Onyx: 1) 6 glomic tumors (4 jugular, 1 vagal, 1 carotid body tumor), 2) 2 nasopharyngeal angiofibromas. For the six glomic tumors it was a palliative treatment, and a preoperative one for the 2 angiofibromas. A distal, intratumoral catheterization was performed with a marathon microcatheter. Only one artery was catheterized in four cases and two arteries in two cases (jugular glomic tumors). For all glomic tumor cases a double femoral approach was performed to better control reflux into vertebral artery feeders. In two cases a balloon microcatheter was positioned into the internal carotid artery to prevent arteriolo-arteriolar reflux.

IMAGING FINDINGS
Complete devascularization was obtained in six cases, partial in two cases. One patient is scheduled for another embolization. No technical complication was encountered. One patient presented a transient facial palsy regressive in 6 hours. No worsening of clinical symptoms (cranial nerves dysfunction) occurred after embolization procedure. All the patients treated by embolization and not operated on underwent a 3-months control MR (a follow-up MR is scheduled every year).

SUMMARY
Intratumoral injection of Onyx by intraarterial approach is an easy technique leading to a very efficient devascularization of hypervascular tumors of the skull base. Long-term follow ups and further experience will be necessary to justify this technique as a palliative alternative to the surgery.

KEY WORDS: Skull base tumors, embolization, Onyx

New Polymeric Aneurysm Embolization Material: Initial Clinical Experience

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PURPOSE
The cPAX Aneurysm Treatment System, comprised of a new polymeric implant material designed to improve packing density, was developed as a new method for endovascular treatment of intracranial aneurysms. We performed a preliminary clinical study to evaluate this new device for safety and efficacy.

PURPOSE
Temporal Resolution of Dynamic CT Angiography in Imaging Time-Dependent Vascular Pathologies Using Flat-Panel CT

Gupta, R. · Mitha, A. P. · Cheung, A. C. · Grasruck, M. · Leidecker, C. · Ogilvy, C. S. · Brady, T.
1Massachusetts General Hospital, Boston, MA, 2Siemens Medical Solutions, Forchheim, GERMANY, 3Siemens Medical Solutions USA, Malvern, PA

PURPOSE
Conventional CT angiography (CTA) is a static snap-shot of the vascular anatomy and is unable to visualize time-varying phenomena. Recently introduced flat-panel volume CT (fp-VCT), consisting of a flat-panel detector with larger z-cov-
Dynamic CTA using fp-VCT has sufficient temporal resolution to discriminate first-pass and recirculation dynamics of contrast bolus and reveal pathologies such as steal phenomena. Brain perfusion is a possibility; however, the temporal resolution is borderline. Aneurysm pulsatility could not be assessed because of aortic arch motion and low temporal resolution.

**Key Words:** Flat-panel volume CT, dynamic CT angiography, temporal resolution
In this image, a hypertrophied meningohypophyseal trunk (black arrows) is noted to supply a small AVF nidus labelled with gray arrow.

**CONCLUSION**

Intraarterial CTA is a safe method for localization and characterization of subtle neurovascular lesions and, in some problematic cases, can facilitate definitive therapy. It can be performed safely in most departments with DSA and multidetector CTs. This technique also can be a very useful tool for studying cross-sectional vascular anatomy.

**KEY WORDS:** DSA, CTA, arteriovenous fistula

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**Paper 332 Starting at 4:37 PM, Ending at 4:45 PM**

**Percutaneous Biopsies of Head and Neck under Multidetector Tomography**

Escobar, W. · Pedroza, A. · Gomez, F.

Universidad del Valle
Cali, COLOMBIA

**PURPOSE**

Various tumors can affect the head and neck area. Their histologic diagnosis and treatment is quite complex, requiring major surgical interventions in many instances to expose the tumor, to obtain a biopsy and subsequently to dissect the lesion, in an attempt to obtain its complete eradication. Some cases require additional treatment, or can only be treated, with radiation therapy and/or chemotherapy. Knowing the histologic diagnosis before the therapeutic surgical intervention allows for better therapeutic planning. We are presenting a series of cases, which demonstrate that with the appropriate technique it is possible to perform percutaneous head and neck biopsies, in order 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 2005 and 2007, 12 percutaneous image-guided biopsies were performed, at our center, in different regions of the head and neck including the anterior cranial fossa, middle fossa, parasellar region, clivus and infratemporal fossa. To reach the lesions we used different approach routes, including: trans-orbital, trans-nasal, retromandibular route, supra and infrrazygomatic. Nine procedures were performed under tomography guidance alone in the tomography suit using the tandem technique. Two biopsies were obtained under CT guidance and then embolization in angiography suite. One case required both CT and fluoroscopic guidance. A 22G needle was inserted first to identify the safest pathway and choose the biopsy site. Subsequently, a 14, 16 or 18G 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 12 lesions and a diagnosis was possible in 12 cases. Histologic diagnosis included: chordoma, chondrosarcoma, rabdomyosarcoma, carcinoma, metastasis, juvenile nasoangiofibroma, pituitary adenoma, lymphoma, meningioma and schwannoma. Three hypervascular lesions were encountered and percutaneously embolized at the time of the biopsy.

**CONCLUSION**

Percutaneous biopsy of the head and neck is possible. It is a safe procedure, and allows histologic diagnosis to plan for appropriate surgical, radiation or chemotherapy treatment and it is a new development in neuroradiology.

**KEY WORDS:** Percutaneous biopsies, multidetector tomography, head and neck

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**Wednesday Afternoon**

3:30 PM – 4:30 PM
Room 204/205

(46) ELC Lecture B: MRI Safety

(333) MRI Safety

— Ulrich A. Rassner, MD

**MRI Safety**

*Ulrich A. Rassner, MD*

Dr. Rassner attended Medical School: Eberhard - Karls Universitat, Tuebingen, Germany from 1988-1998. He took a Surgical Internship at Washington Hospital Center, Washington, DC from 2000-2001. From 2001-2005 Dr. Rassner performed a Diagnostic Radiology Residency at the University of Utah, Salt Lake City, UT. From 2005-2007 he did a Fellowship in Neuroradiology at the University of
Utah, Salt Lake City, UT and from 2007 to the present Dr. Rassner is Assistant Professor of Radiology, University of Utah, Salt Lake City, UT.

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Cite safety concerns with patients and non-MRI personnel.
2) Discuss safety testing of devices and labeling standards.
3) Discuss the perspective of interaction of major groups of devices with MRI.
4) Discuss current effects of gadolinium contrast agents in renal failure patients.

**PRESENTATION SUMMARY**
Magnetic resonance imaging (MRI) is one of the safest but at the same time one of the most dangerous imaging modalities. Understanding of the interaction of MRI with patients and medical and nonmedical device is important to ensure patient and MR personnel safety, as is an appreciation of the lack of knowledge of lay people regarding the potential dangers of static magnetic field. This presentation will address the safety concerns regarding the interaction with lay people in the MR environment, safety standards set by the FDA and general information regarding device testing for MRI safety as well as labeling standards. Common groups of devices and their safety status will be addressed, also in regards to the now more commonly found 3 T MR scanners. A brief overview of the current status of the effects of gadolinium use in renal failure patients in respect to Nephrogenic Systemic Fibrosis (NSF) will be provided. Finally a short discussion of emergency procedures at the MR scanner such as quench and emergency stop will be given.

**Wednesday Afternoon**
4:45 PM – 6:15 PM
Room 208/209

(47) (ASFNR) State of the Art Brain Tumor Presurgical Mapping II: Beyond BOLD Plus Practical Considerations

(334) DTI for Delineation of Eloquent White Matter Tracts and Intraoperative Validation
— Pratik Mukherjee, MD, PhD

(335) Clinical MEG: Useful Supplement to BOLD fMRI
— Timothy P. L. Roberts, PhD

(336) The Need to Assess Cerebral Vascular Reactivity in Preoperative Clinical fMRI Studies
— David J. Mikulis, MD

(337) CPT Codes and Reimbursement for Functional Imaging
— Scott H. Faro, MD

Moderator: Jeffrey R. Petrella, MD

**DTI for Delineation of Eloquent White Matter Tracts and Intraoperative Validation**
Pratik Mukherjee, MD, PhD

**LEARNING OBJECTIVES**
Upon completion of this presentation, participants will be able to:
1) Examine current techniques for performing DTI fiber tracking.
2) Demonstrate mapping of eloquent white matter pathways in patients with brain tumors, combined with functional localization techniques such as fMRI, MEG, and intraoperative cortical stimulation.

**PRESENTATION SUMMARY**
Although techniques such as functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG) for preoperatively localizing eloquent regions of cerebral cortex are now in widespread use, the mapping of functionally important white matter tracts has lagged behind despite its
obvious importance for preventing surgical morbidity. This has begun to change with the adoption of diffusion tensor imaging (DTI) tractography. In this presentation, current techniques for performing DTI fiber tracking are examined, broadly categorized into “deterministic” and “probabilistic” methods. The present strengths and weaknesses of each of these methods are introduced that may overcome some of the limitations of diffusion imaging (HARDI) techniques for tractography are cortical stimulation. Finally, newer high angular resolution diffusion imaging (HARDI) techniques for tractography are introduced that may overcome some of the limitations of DTI fiber tracking.

Clinical MEG: Useful Supplement to BOLD fMRI
Timothy P. L. Roberts, PhD

Dr. Roberts obtained his PhD from Cambridge University, England in 1992. He undertook a post-doctoral fellowship in the field of diffusion and perfusion MRI in the Department of Radiology at UCSF with Mike Moseley and John Kucharczyk. He has subsequently been on the faculty at UCSF, where he established the Biomagnetic Imaging Laboratory, 1993 and the University of Toronto and is presently holder of the Oberkircher Family Chair in Pediatric Radiology and Vice-Chair for Research in the Department of Radiology at Children’s Hospital of Philadelphia as well as Professor Radiology, University of Pennsylvania. His work in 4D functional imaging using biomagnetic recording, specifically in the study of auditory processing and language has been supported by the National Alliance for Autism Research and is presently supported by Autism Speaks, the Nancy Lurie Marks Family Foundation, the Commonwealth of Pennsylvania and NIH. He has published in excess of 200 scientific papers, mostly in the field of physiologic and functional imaging, reviews grant proposals for NIH and several equivalent international agencies, and serves on the executive committee of the American Society for Neuroradiology, the American Society for Functional Neuroradiology and the International Society for the Advancement of Clinical MEG.

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review the neurophysiological basis of the MEG signal.
2) Discuss the role of MEG in identifying the source of epileptiform electrical activity.
3) Review the role of MEG in identifying functional cortex involved in simple and complex tasks.

Presentation Summary
Many of the determinants of brain function (normal and abnormal) are influenced by the genetic codes giving rise to structural and functional features of the brain. Our immediate interaction with the world, however, is electrochemical in nature - release of neurotransmitters, action potentials in neurons, and synaptic events. Electromagnetic activity occurs on a timescale measured in fractions of a second, and such rapid processing and transmission of information is needed to successfully interact with our environment. Thus, understanding the brain necessitates the use of non-invasive technologies that are (i) sensitive to activity at the neuronal level, and (ii) sufficiently fast to track dynamic processes with millisecond or better temporal resolution. Although MRI-based functional imaging has advanced considerably over recent years, an inherent limitation of functional MRI (fMRI) is the poor temporal resolution intrinsic to hemodynamic phenomena (blood oxygenation and blood flow). As such, fMRI is unable to track rapidly changing neural activity within and across brain regions. Alternative imaging methods are needed that complement fMRI in evaluating brain activity in the healthy brain as well as in patients with neurologic and psychiatric disorders. Magnetoencephalography (MEG) measures electromagnetic neural activity. The temporal resolution of MEG is limited only by the data acquisition rate, thus allowing real-time (~ms) assessment of brain electrophysiology. As such, MEG has the temporal resolution needed to detect ongoing oscillatory activity as well as isolated bursts of electrical discharge (e.g., interictal epileptiform activity). Propagation of brain activity can also be assessed. This presentation describes the technique and principles of MEG in the context of clinical assessment of brain activity in patients referred for presurgical mapping of eloquent cortex and the identification of zone(s) of interictal discharge in seizure disorders. While the ability of MEG to resolve and localize brain activity is under continuous discussion, evaluation, and improvement, numerous studies have demonstrated the utility of MEG source localization, and this technique is now commonly used in the clinical definition of eloquent cortex prior to neurosurgical procedures (Nakasato & Yoshimoto, 2000; Alberstone et al., 2000; Schiffbauer et al., 2002; Ganslandt et al., 2004; Lee et al., 2006), as well as in the localization of the source(s) of interictal epileptiform activity (Knowlton et al., 2006). MEG technology, MEG clinical applications, and the future of MEG as a clinical tool are considered.

The Need to Assess Cerebral Vascular Reactivity in Preoperative Clinical fMRI Studies
David J. Mikulis, MD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Review the physiological mechanism underlying the fMRI signal.
2) Discuss how vascular diseases can confound the fMRI signal.
3) Review why a map of cerebrovascular reserve/reactivity can be useful in validating the reliability of the fMRI map in patients with vascular diseases.
4) Review how to implement CVR mapping as part of the fMRI acquisition.

Presentation Summary
Functional MRI studies (fMRI) are now becoming a routine part of the preoperative assessment of patients undergoing surgical intervention for intracranial lesions. The primary goal of these studies is to map "eloquent" networks such as...
those associated with motor, language, and memory function. Knowledge of the spatial relationship of these networks to brain lesions can influence surgical approach and extent of resection (1). Functional MRI, however, is a signal "starved" test requiring statistical averaging of thousands of images to pull the signal out of the noise. In fact, most brain mapping studies have utilized groups of subjects, usually ten or more, in order to reliably map a single functional network. From a clinical perspective, we must make the assumption that these networks can be mapped reliably in a single subject. A second assumption, that almost never goes challenged, is the dependency of the fMRI response on adequate vascular reserve. Functional MRI images show the presence of neuronal activation based on the washout of deoxyhemoglobin. Active neurons release a signal to the microvasculature promoting arteriolar relaxation resulting in an increase in local blood flow. The ensuing flow augmentation is three times higher than the increase in oxygen extraction producing a decrease in deoxyhemoglobin in the microcirculation (2). What happens if precapillary arterioles are already partially dilated as a compensatory response to proximal carotid stenosis or occlusion? The result will be a muted flow response and either no change in deoxyhemoglobin concentration or even and increase! This can lead to false negative results with potentially adverse surgical consequences. It would seem desirable to screen for this potentially confounding physiological condition. In patients at risk for vascular disease, a breath-hold cerebrovascular reactivity (CVR) analysis can reveal the impact of the disease on vascular reserve (3). The following describes a simple and feasible implementation of this technique. CVR mapping can be performed as a continuation of the last clinical fMRI acquisition. It is added during, and at the end of, the fMRI pulse sequence, provided that the patient can hold their breath for three 25-second epochs intermixed with normal respiration. This additional 150 seconds of data acquisition, ("block design" - hypercapnea interleaved with normocapnea) is analyzed in exactly the same way as the fMRI data that preceded it, and can yield a qualitative CVR map. We believe this is an important validation of fMRI mapping studies performed in patients with cerebrovascular disease and in those with arteriovenous malformations.

REFERENCES

CPT Codes and Reimbursement for Functional Imaging

Scott H. Faro, MD

REPRESENTATION SUMMARY
Summary of fMRI CPT code process. This presentation will give an overview of how the CPT process works for new Neuroradiology CPT codes. The CPT code process for fMRI began in early 2004 and was a coordinated effort of many professional societies such as: ASNR, ASFN, ACR, and the AAN. The ASNR and ASFN Clinical Practice Committee; CPT Coding and Reimbursement Subcommittee coordinated the fMRI CPT code process. Three national committee's are needed to approve their component of the CPT process. The committees include:

1. AMA CPT Editorial Panel - A multispecialty panel which deals with coding and nomenclature issues. Its main charge is to maintain the Current Procedural Terminology (CPT) manual. This includes approving new codes, editing existing codes to reflect current practice, creating modifiers, etc. The CPT Editorial Panel approved level I CPT codes for fMRI at its October 2005 meeting in Seattle.
2. RVU Update Committee (RUC) - The RUC is a panel consisting of physician members from multiple specialties, overseen by the AMA. The RUC reviews each newly approved procedure code and assigns RVUs (relative value units) for practice expense as well as physician work involved in the new procedure. After surveys were performed the specialty societies presented recommendations for values to the RUC at the February 2006 meeting in Miami the RUC approved negotiated values.
3. The Centers for Medicare and Medicaid Services (CMS) - CMS reviews the new codes and the RUC recommended values and decides whether to change them. In November 2006 CMS issued a notice in the Federal Register which listed fMRI as payable codes with values, as approved by the RUC. Currently the codes are published officially with the values assigned by the RUC and the codes are assigned a 'payable' status by CMS.

A Summary of the CPT descriptors and values are as follows:
70554 - Magnetic resonance imaging, brain, functional MRI; including test selection and administration of repetitive body part movement and/or visual stimulation, not requiring physician or psychologist administration (Approved at 2.11 RVUs for physician work and a total of 2.81 RVUs for professional payment, 13.71 RVUs for technical payment adding up to 16.52 RVUs when billed globally) 70554 is not to be reported in conjunction with 96020 or 70555.
70555 - Magnetic resonance imaging, brain, functional MRI; requiring physician or psychologist administration of entire neurofunctional testing (Approved at 2.54 RVUs for physician work for a total of 3.37 RVUs) 70555 can only be reported when 96020 is performed.
96020 - Neurofunctional testing selection and administration during noninvasive imaging functional brain mapping, with test administered entirely by a physician or psychologist, with review of test results and report. (Approved at 3.43 RVUs for physician work for a total of 4.46 RVUs.) Do not report 70554 & 70555 in conjunction with 70551-53 unless a separate diagnostic MRI is performed.

Two last points will be discussed: A review of clinical fMRI reporting and continuing reimbursement issues. Medicare at national or local level, as well as any private payers can still publish coverage decisions. Local discussions with payers may be necessary.
Natural History of Cerebral AVMs

Philip M. Meyers, MD

Learning Objectives

Upon completion of this presentation, participants will be able to:
1) Diagnose of Arteriovenous Malformation (AVM).
2) Incidence and Prevalence of Cerebral AVM.
3) Natural History Risk of Cerebral AVM.
4) Treatment of Cerebral AVM.

Presentation Summary

I. Overview.
II. Classification of brain AVMs: 4 types.
III. Presentation and pathophysiology.
IV. Evaluation.
V. Treatment modalities.
VI. Natural history and the ARUBA Trial.

Diagnostic Imaging Techniques for Cerebral Vascular Malformations

Robert C. Wallace, MD

Learning Objectives

Upon completion of this presentation, participants will be able to:
1) Review the classification of cerebrovascular malformations.
2) Recognize imaging features of different types of cerebrovascular malformations.
3) Define the role of different diagnostic imaging modalities in the work up of cerebrovascular malformations.

Presentation Summary

Cerebrovascular malformations of the brain have been traditionally classified into four types: capillary telangiectasia, cavernous malformation, developmental venous anomaly (previously referred to as venous angioma) and arteriovenous malformation (or AVM) since McCormick’s original description in 1966. These lesions are distinct from dural fistulas and vein of Galen malformations and these later lesions will not be a part of the following discussion. Each type of cerebrovascular malformation has characteristic imaging features that will be the focus of this topic.

Capillary Telangiectasia

Capillary telangiectasias histologically are composed of dilated endothelial lined capillary structures that have intervening brain parenchyma. These lesions are clinically silent with rare reports of symptoms or hemorrhage. They are usually found incidentally on MRI. On MRI the lesion has isointense signal to brain on T1 and T2 weighted sequences. They are most often visualized when intravenous contrast is administered and the lesion enhances. On susceptibility sensitive Gradient Refocused Echo sequences (GRE) the lesion is characterized by decreased signal intensity. This finding is likely due to deoxygenation of hemoglobin caused by slow blood flow that causes susceptibility effect and resultant signal loss.

Cavernous Malformation

Cavernous Malformations (CMs) are histologically identified by markedly enlarged endothelial lined spaces filled with blood or thrombus and they have no intervening brain parenchyma. These lesions may become symptomatic because of hemorrhage and are commonly epileptogenic. On MRI the lesion is evident by various stages of blood products and thrombus evolution within the lesion. The various stages of hemorrhage result in mixed signal intensities depending on the stage of blood breakdown products that are present. The lesion is always surrounded by a continuous uninterrupted margin of hypointense signal on long TR, long TE sequences. This finding is more evident on conventional spin echo sequences than Fast Spin Echo (FSE) sequences and becomes larger and more evident (“blooms”) on GRE sequences.
sequences. The majority of CMs do not enhance following gadolinium contrast administration, but a small portion of them will have enhancement as a normal finding. Contrast administration may also demonstrate an associated anomalous venous structure at the margin of the lesion.

**Developmental Venous Anomalies**

DVAs are congenital anomalies of venous development that drain normal brain and are rarely ever symptomatic. Histologically, they are lined by endothelial cells and the wall contains smooth muscle. These lesions are commonly seen on imaging studies and have a characteristic appearance of multiple venous tributaries that converge on a single draining vein. They are usually well visualized after gadolinium contrast administration on MRI and CT.

**Arteriovenous Malformations**

AVMs are vascular malformations with an abnormal arterial, capillary and venous connection. In place of a capillary system there is a disorganized vascular network connecting the feeding arteries and draining veins. The most common presentation is an acute neurological deficit due to hemorrhage; but, seizures, headaches and non-hemorrhagic neurologic deficits are also common. Certain features of an AVM are predictive of an increased risk of bleeding if left untreated and include nidal and feeding artery aneurysms, deep location, central venous drainage, small nidus size, single draining vein, venous stenosis and varix formation. Many of these features are evident on non-invasive imaging studies. Nidal aneurysms associated with AVMs may be hidden on CTA and MRA techniques because of the overlapping vessels thus requiring catheter angiography for careful evaluation. Other imaging features including location adjacent to sensitive anatomic structures, lesion size, central venous drainage, perforator vascular supply and nidus margins may be helpful to the surgeon to predict difficulty of resection and neurological outcome from surgical treatment.

### Endovascular Management of AVMs: Patient Selection for Palliation Adjunctive, Therapy or Cure

*Thomas J. Masaryk, MD*

**Presentation Summary**

Vascular malformations of the central nervous system can be categorized a number ways. A simplistic and utilitarian classification is to divide the lesions into those that involve the brain substance and those which that primarily involve the dura. Pial Arteriovenous Malformations (AVMs) are a spectrum developmental anomalies, with a unique, but vaguely understood vascular pathophysiology. The sine qua non of AVM pathology is arterial shunting to draining veins in the absence of capillaries. The pathologic hallmarks of arteries/arterioles feeding directly to nidal vessels have a distinctive correlate of angiographic shunting. Variability of lesions can be appreciated as a spectrum from a compact, tight nidus without significant intervening brain parenchyma to diffuse, reticulated anastomotic channels with a lobar or even hemispheric distribution. Regardless of where they fall on this spectrum, the propensity for some AVMs to bleed has histologic and pathologic correlates in microscopic areas of hemosiderin and gliosis (even in the absence of an apoplectic event) as well as macroscopic features such as arterial aneurysms and central venous drainage. The risk of surgical intervention has been directly related to: the size of the AVM, the location (i.e. eloquence of the surrounding brain), and the pattern of venous drainage, (deep or superficial.) These relationships are best characterized with the Spetzler-Martin grading system. The role of neuroendovascular therapy in the management of brain AVMs depends ultimately on the overall treatment plan. In general, five scenarios comprise the vast majority of rational management strategies (listed from most to least common):

1. Preoperative: embolization as precursor to curative surgical resection
2. Targeted therapy: embolization to eradicate a specific bleeding source
3. Preradiosurgery: embolization as a precursor to radiation therapy
4. Curative: embolization for attempted cure
5. Palliative: embolization to palliate symptoms attributed to shunting

Dural arteriovenous malformations (DAVMs) or dural arteriovenous fistulae (DAVF) are acquired lesions consisting of one or more fistulous connections within the leaflets of the dura mater. They account for 10 to 15% of cranial arteriovenous malformations. The majority, if not all of these lesions, are acquired. Most lesions appear in middle age or the elderly; far later than typical pial AVMs. Specific factors are known to predispose to fistula formation including sinus thrombosis/ coagulopathy, trauma, and surgery. The clinical presentation of DAVFs is highly varied and is primarily determined by the location of the fistula and the subsequent pattern of venous drainage. Other factors include the degree of AV shunting, venous hypertension, and presence of venous stenoses or ectasia. The primary factor in determining the aggressive behavior of a DAVF, however, is the presence of leptomeningeal venous drainage which can engender venous hypertension, progressive neurologic deficit, infarction, and hemorrhage. Unlike pial AVMs of the brain, the venous drainage of a DAVF can frequently be safely ligated, excised, or occluded prior to occlusion of all the arterial pedicles. However, profuse bleeding can occur during surgical exposure due to the arterialized dura, pedicles, and drainage into the intradiploic vascular channels. Sinus skeletonization or excision of DAVFs should be reserved for those cases where endovascular therapy has failed to effect a cure. Transvenous embolization of fistulae, as popularized by Halbach et al, has been used with good success and is especially effective in the treatment of DAVFs. Consideration of the venous drainage of the fistula itself as well as the drainage of normal cerebral tissue is paramount in minimizing risk. Trans-arterial embolization may also be employed adjunctively with trans-venous embolization, or alone in instances where venous access is compromised.
Radiology of Scoliosis

Johan W. Van Goethem, MD, PhD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Define scoliosis and be able to classify it according to existing criteria.
2) Summarize the most frequent etiologies of scoliosis.
3) Define the most appropriate imaging technique in scoliosis.

Presentation Summary
In the frontal plane the normal load-bearing spine is straight. Scoliosis is defined as a deviation from the midline in a frontal plane. A small deviation (<10°) is sometimes called spinal asymmetry, while ‘true’ scoliosis has a deviation of ≥10°. This deviation is accompanied by a rotation that is maximally at the apex of the curve. The prevalence of scoliosis (≥10°) in the childhood and adolescent population is between 0.5 and 3.0%.

Etiology
Congenital scoliosis is the most frequent congenital spinal deformity. It is the result of embryologic or intrauterine maldevelopment of vertebral elements. They may be caused by either failure of formation or failure of segmentation. Most frequently scoliosis is idiopathic (80%). Substantial research efforts have identified several factors contributing to the development of idiopathic scoliosis. Genetic factors are a potential etiologic component in the development of scoliosis. Also, central nervous system disorders may result in scoliosis. Several factors have been identified that correlate with a higher incidence in scoliosis, such as equilibrium and vestibular dysfunction, melatonin deficiency, syringomyelia and spinal tumors.

Classification
Scoliosis can be classified according to etiology, curve location, age at onset and/or curve type.

Imaging
Imaging in scoliosis is very important. It is used routinely in monitoring the changes of the deformity that take place during growth. Imaging is also crucial in determining the underlying etiology in non-idiopathic cases of scoliosis. Finally, imaging is used in pre- and postoperative monitoring. The ideal imaging modality for screening in scoliosis is the upright posteroanterior radiograph of the entire spine. A lateral film is not required as a part of the screening examination. Radiographic techniques should be used to minimize radiation of sensitive organs (breast, thyroid, ovaries, bone marrow, lens, ¼). It is imperative that radiation-lowering techniques are used judiciously to minimize the radiation burden. At least when surgical treatment is considered lateral bend radiographs and a lateral film should be acquired. Computed tomography (CT), especially multirow detector CT (MDCT), is the best method for visualization of complex scoliotic deformities. Magnetic resonance imaging (MRI) is required in infantile and juvenile idiopathic scoliosis, congenital bony anomalies and scoliosis associated with specific neurological or cutaneous abnormalities.
Quantitative MR Perfusion Methods

Timothy J. Carroll, MD

Dr. Timothy J. Carroll, Ph.D. has been active in the study of cerebral perfusion and stroke since 1999. Originally trained in the field of high energy physics at the University of Illinois and Max-Planck Institute in Munich, he joined the MRI imaging research group and the University of Wisconsin-Madison in 1997. He has published extensively on both MRI based time-resolved angiography and cerebral perfusion over the past ten years. A native Chicagoan, he joined the faculty of Radiology and Biomedical Engineering at Northwestern University in 2002. His recent accomplishments include: the development of a program to create cerebral perfusion images in-line, without the need for user input, a means by which to quantify cerebral perfusion (in ml/100g-min) and a high frame rate angiography technique that acquires 3D MR images at 6 frames/sec.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Illustrate advances in MR perfusion imaging.
2) Describe basics of MR perfusion images.

PRESENTATION SUMMARY
We describe an approach to quantification of cerebral perfusion based on the bookend technique which attempts to accurately determine cerebral blood volume (CBV) from T1 changes induced by the injection of a T1-shortening contrast agent. In our approach a single slice Look-Locker T1 measurement is acquired before and after a contrast-enhanced MR perfusion scan. The residual intravascular contrast serves a T1-shortening agent for perfusion quantification. This approach relies on careful modeling of the effects of intravascular to extravascular water exchange, which is a well-known confounding effect in determining CBV from pre- and post gadolinium T1-changes. Having accurately determined CBV, cerebral blood flow (CBF) can be determined using Mean Transit Time (MTT) calculated from deconvolution analysis and the central volume principle. The bookend approach to cerebral perfusion also allows for accurate quantification of blood volume and flow using spin-echo perfusion images, which are known to be less sensitive to signal loss near air/tissue interface. We have performed a comprehensive evaluation of this novel approach to quantification. Results on the accuracy, reliability and reproducibility will be presented. In this presentation, the basics of cerebral perfusion imaging will be reviewed for the non-expert. The "bookend technique" formalism will be introduced and described. Recent results in patients with cerebral vascular disease and will be presented.

Advances in Arterial Spin Labeling

David Alsop, PhD

David Alsop received his PhD in Physics from the University of California, Berkeley and training in medical imaging as an NRSA postdoctoral fellow at the University of Pennsylvania Medical Center. He is Director of MRI Research at the Beth Israel Deaconess Medical Center, Department of Radiology and an Associate Professor of Radiology at Harvard Medical School. He has served as a Deputy Editor of Magnetic Resonance in Medicine since 2000. He has authored and co-authored over 90 peer reviewed papers and is the recipient of multiple NIH grants. His research has focused on the development of MRI methods for the improved characterization of tissue function and pathology and especially the development and application of MRI perfusion techniques.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss how arterial spin labeling can be used to generate perfusion images.
2) Illustrate recent advances in arterial spin labeling that enhance clinical robustness.
3) Discuss the strengths and weakness of arterial spin labeling for clinical neuroimaging.

PRESENTATION SUMMARY
Arterial spin labeling, or ASL, is a technique that permits the generation of quantitative images of perfusion without contrast injection. Instead, ASL uses magnetic fields to selectively alter the signal from inflowing arterial blood, such that the endogenous water in arterial blood becomes the tracer. While ASL has until recently been primarily a research novelty, new techniques and improving vendor support are making ASL a potentially routine technique for the characterization of brain pathology and function. This presentation will review the basic concepts of ASL including labeling approaches and quantification. Newer approaches that enhance the clinical robustness of ASL and permit the routine use of ASL will be described. The strengths and weaknesses of ASL relative to other perfusion methods will be discussed. Finally examples of application of ASL to brain tumors, dementia and other clinical pathologies will be presented.

REFERENCES

MR Flow Techniques

David Saloner, MD
Wednesday Afternoon

5:00 PM – 6:30 PM
Room 204/205

(51) ELC Workshop E: Advanced Web Design

(346) Advanced Web Design  
— Dale A. Charletta, MD
Thursday Morning
7:45 AM – 8:45 AM
La Louisiane Ballroom

(52) Maintenance of Certification (MOC) – Interventional and ENT Review
Audience Response Plus+ (AR+)*

(347) Interventional
  — Daniel P. Hsu, MD

(348) ENT
  — C. Douglas Phillips, MD

Moderator: C. Douglas Phillips, 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.

Thursday Morning
8:45 AM – 10:00 AM
La Louisiane Ballroom

(53) General Session: Intraoperative Imaging

(349) Interventional MR
  — Jonathan S. Lewin, MD

(350) Intraoperative MR - The Neurosurgical Perspective
  — Walter A. Hall, MD, MBA

(351) Intraoperative Imaging
  — Eric Lis, MD

Moderator: Eric Lis, MD

ENT
C. Douglas Phillips, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the normal development of the sinonasal cavity.
2) Review normal anatomy of the sinonasal cavity.
3) Differentiate a variety of developmental lesions of the sinonasal cavity.

PRESENTATION SUMMARY
Through a review of normal development and normal anatomy of the sinonasal cavity, I hope to leave the audience with an understanding of normal sinus function, structure, and also provide the background to understand a series of developmental pathology of the sinuses and nasal cavity. Normal development will be discussed in detail, particularly as it pertains to the more common sinonasal developmental lesions, particularly the development of the frontonasal region and ethmoids.
Interventional MR

Jonathan S. Lewin, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Describe the concepts of image-guided percutaneous therapy.
2) Summarize uses of MRI for interventional guidance.

PRESENTATION SUMMARY
During the past decade, there has been increasing emphasis on intervention in the practice of Neuroradiology. Parallel with this phenomenon has been an increased interest in the use of MRI for guidance of radiologic procedures. Until recently, the long imaging times and difficulty in patient access provided by cylindrical systems made MR an unlikely guidance modality. These disadvantages have been overcome with the advent of system hardware and pulse sequence improvements that have allowed the development of rapid imaging on open systems, along with the development of high-field systems that allow access to the patient. Percutaneous procedures performed on these interventional MR systems include biopsy and aspiration and percutaneous minimally invasive therapy. The tissue contrast, spatial resolution, vascular conspicuity, and multiplanar capabilities of MRI have obvious benefits for guidance of biopsy and aspiration applications. These procedures have greatly benefited from the development of in-room image monitors, integrated frameless stereotaxy systems, and rapid pulse sequences for use in percutaneous procedures. The high tissue contrast and vascular conspicuity of MR imaging is particularly well suited to biopsy and drainage of tumors and cysts in the head and neck. For many of these procedures, the rapid frame-rate and high visibility of nearby vessels provided by 2D gradient-echo MR techniques allow needle placement in less time than required with CT guidance, with less than 8 minutes required per needle pass. Much of the excitement surrounding MR image-guided procedures has been due to the tremendous sensitivity of MR imaging for temperature change and tissue damage. Many of the studies looking at thermal ablation of brain tumors under MR image guidance are preliminary, but have shown encouraging initial results. Pilot data also has been obtained using thermal ablation for treatment of tumors of the head and neck. The key advantage of MRI that has been driving the development of these techniques has been the ability to monitor tissue destruction in near real-time during the procedure using a variety of MR imaging techniques, allowing interactive repositioning of the interventional device and tailoring of the thermal lesion in order to provide adequate destruction of the targeted tumor and surrounding margin of normal tissue. The striking conspicuity of low flow vascular malformations on MR images, along with the capacity for interactive multiplanar imaging, increased access to the patient, and rapid temporal resolution provided by recently developed MR imaging systems, suggests that MR guidance also maybe optimally suited for sclerotherapy of these lesions.
Intraoperative Imaging

Eric Lis, MD

Thursday Morning

10:30 AM – 12:15 PM
La Louisiane Ballroom

(54a) SPINE: Spinal Cord, Neoplasms & Other/Excerpta
(Scientific Papers 352 – 366)

See also Parallel Sessions
(34b) INTERVENTIONAL: Aneurysms II
(54c) ADULT BRAIN: Miscellaneous
(54d) ADULT BRAIN: New Techniques & Postprocessing

Moderators: Gregory W. Peterman, MD
Alain L. Williams, MD, FACR, MBA

Paper 352 Starting at 10:30 AM, Ending at 10:40 AM
Combination of IDEAL and ARC Imaging to Obtain Homogeneous Fat Saturation in the Brachial Plexus within Clinically Acceptable Time Parameters

Grayev, A. M. · Reeder, S. · Haughton, V. · Gentry, L.
University of Wisconsin
Madison, WI

PURPOSE
Comprehensive MR imaging of the brachial plexus has been severely limited by poor fat suppression. The IDEAL (Iterative Decomposition of water and fat with Echo Asymmetry and Least squares estimation) is a three-echo, chemical shift based approach that can provide homogeneous separation of water and fat despite B0 and B1 inhomogeneities [1]. Although IDEAL has been successfully applied to the brachial plexus [2], it suffers from a three-fold increase in scan time. The purpose of this study was to combine IDEAL imaging with Autocalibrating Reconstruction for Cartesian sampling (ARC) parallel imaging to reduce the minimum scan time while maintaining a high signal to noise ratio (SNR).

METHODS & MATERIALS
IDEAL-ARC images were reconstructed with an on-line reconstruction algorithm, which provides separate water, fat and recombined in-phase (water + fat) and out of phase (water - fat) images, following acquisition of T1 and T2 weighted images. The remainder of the examination was completed using traditional T1 and T2 FSE sequences without and with fat saturation.

RESULTS
Uniform separation of water and fat was seen throughout the brachial plexus. Images had high SNR and excellent image quality was seen in all images.

Figure 1: Axial T1 FSE with fat saturation demonstrating areas of failed fat suppression as well as areas of water suppression.

Figure 2: Axial T1 FSE IDEAL-ARC demonstrating homogeneous fat suppression while maintaining high SNR.

Figure 3: Coronal T2 FSE with fat saturation demonstrating failed fat suppression.
Figure 4: Coronal T2 FSE IDEAL-ARC demonstrating homogeneous fat suppression and high SNR.

**CONCLUSION**

IDEAL imaging provides homogeneous fat saturation throughout the brachial plexus; however, until recently, the length of time needed to acquire the images limited clinical applicability. Combining ARC parallel imaging with IDEAL allows maintenance of high SNR performance within clinically acceptable scan durations.

**REFERENCES**


**Paper 353 Starting at 10:40 AM, Ending at 10:48 AM**

**MR Perfusion Imaging and Diffusion Tensor Imaging of Tumor and Tumor-Like Lesions of the Cervical Spinal Cord**

Liu, X. · Tian, W. · Ekholm, S. · Westesson, P.
University of Rochester School of Medicine & Dentistry Rochester, NY

**PURPOSE**

To evaluate the perfusion and diffusion characters of tumor and nonsurgical tumor-like lesions in cervical spinal cord by MR perfusion-weighted imaging (PWI) and diffusion tensor imaging (DTI).

**MATERIALS & METHODS**

Cervical dynamic susceptibility contrast(DSC)-GRE-PWI and cervical DTI(EPI sequence TR/TE=10000/85, b=1000s/mm², 25 directions; FOV 20) scan were performed on 16 patients with GE 1.5 T MR scanners. There are seven patients with tumors, including pathology confirmed ependymoma, meningioma and astrocytomas. There are nine cases with nonsurgical lesions including one patient with radiation injury for medulloblastoma and three patients with enhancing demyelinating lesions; three patients were with myelomalacia; the other two were sequela of demyelinating disease. Trace apparent diffusion coefficient (trace ADC), fractional anisotropy (FA) and eigenvalues ($\lambda_1$, $\lambda_2$, $\lambda_3$) of DTI and relative cerebral blood volume (rCBV) in the PWI were calculated by Functool on a GE workstation. Above parameters of tumors and tumor-like lesions were compared by Mann-Whitney test.

**RESULTS**

Mean rCBV ratio of tumors (2.01±0.66) is significant higher than in the tumor-like lesions (0.42±0.22), $P =0.000$. Except for one case of pathology confirmed astrocytoma, which had increased FA than surrounding spinal cord, mean FA value of tumors is 0.206±0.08; mean trace ADC value is 1.14±0.426; mean $\lambda_1$ value is 1.365±0.441; mean $\lambda_2$ value is 1.136±0.436; mean $\lambda_3$ value is 0.936±0.418. Mean FA value of tumor-like lesions is 0.414±0.115; mean trace ADC value is 0.785±0.181; mean $\lambda_1$ value is 1.241±0.234; mean $\lambda_2$ value is 0.713±0.201; mean $\lambda_3$ value is 0.514±0.212. Comparing with nonsurgical tumor-like lesions, the mean FA value of tumors is significant lower, $P =0.005$; there is no significant difference of mean trace ADC value and eigenvalues.

**Figure.** Scatter map of ratios rCBV of all lesions. Figure shows tumors with significant higher ratio rCBV than tumor-like lesions.

**CONCLUSION**

Combining perfusion and anisotropy abnormality of tumor and tumor-like lesions in the cervical spinal cord, cervical PWI and DTI are useful for clinical diagnosis, potentially could be used as a putative marker in differentiating the surgical tumors from nonsurgical tumor-like lesions.

**KEY WORDS:** Perfusion imaging, diffusion tensor imaging, tumor

**Paper 354 Starting at 10:48 AM, Ending at 10:56 AM**

**Diffusion Tensor Imaging of the Cervical Spinal Cord in Patients with Multiple Sclerosis with and without T2 Visible Lesions: A Multicenter Study**

Mueller-Mang, C.· Law, M.· Pollack, E.· Lee, S.· Meyer, S.· Carson, R.· Thurnher, M. M.
1Medical University of Vienna, Vienna, AUSTRIA, 2Mount Sinai Medical Center, New York, NY

**PURPOSE**

Conventional MRI of the cervical spine is of limited use in monitoring disease progression and therapeutic effect in patients with multiple sclerosis (MS). Furthermore it frequently lacks correlation with clinical disability. The purpose of this study was to measure DTI metrics of the cervical spinal cord in patients with MS, and to correlate the measurements with the DTI metrics of healthy volunteers.
MR imaging of the cervical spinal cord including DTI was performed at two institutions in 19 patients with MS and in 19 healthy volunteers. All patients and volunteers underwent sagittal and axial DTI using pulsed gradient, double spin-echo echo-planar imaging (TR/TE 2000/74; 128x128 matrix; 140x140 mm FOV; 10 contiguous 4 mm slices; b=1000 s/mm2). At C2-3 average fractional anisotropy (FA) and apparent diffusion coefficient (ADC) were calculated within regions of interest (ROIs) at bilateral anterior, lateral, posterior and central white matter regions of the cord. In addition, conventional T2-weighted MR sequence was performed in all patients and according to the findings at the C2-3 level patients were assigned to one of the following groups: 1) no T2 visible lesion; 2) focal T2 visible lesion; 3) diffuse signal changes and atrophy. The statistical significances of the computed DTI metrics were assessed using a paired, double-tailed student t test (p<.05 was considered statistically significant).

RESULTS
The average age of patients with MS was 41 years versus 37 years in the control group. Nine patients had no abnormalities on conventional T2-weighted MR images; seven patients had focal MS lesions, and three patients had diffuse signal abnormalities and atrophy. Compared with control subjects FA was significantly lower in patients in the anterior (mean 0.53), lateral (mean 0.59), posterior (mean 0.63), and central (mean 0.74) ROIs at the C2-3 level with the lowest mean values in patients with T2 visible lesion and in patients with spinal cord atrophy. The mean FA of MS plaques was significantly lower comparing to normal-appearing white matter (NAWM) of the cord, and control subjects.

CONCLUSION
Patients with MS (with and without T2 signal abnormalities) demonstrate changes in DTI metrics measured in the cervical spinal cord at the C2-3 level compared to healthy volunteers. This study shows that damage occurs in the cervical cord of MS patients, in the absence of signal abnormalities on conventional MR imaging. However, DTI can not be used alone, a multiparametric MRI approach is needed to estimate cord damage in MS.

KEY WORDS: Multiple sclerosis (MS), diffusion tensor MR imaging (DTI), cervical spine

Neck CT perfusion studies obtained in 38 patients (N1, median age=57.5 years, 26 males) with head and neck malignancies and no history of spinal cord pathology were reviewed. Sixteen patients previously had undergone RT of the head and neck (median dose=70 Gy; median interval between RT and imaging=12 months) and 22 patients had never been treated with RT. In a separate group of four patients (N2, median age=53.5 years, 4 males) neck CT perfusion studies were obtained before RT, after administration of 40 Gy, and after treatment completion (median dose=70 Gy). After a standard contrasted neck CT, perfusion CT studies were obtained and included the area treated with RT. Data were postprocessed with a software package using a deconvolution-based analysis technique. The vertebral artery and internal jugular vein were used as arterial input and venous output function. Spinal cord blood flow (scBF), blood volume (scBV), mean transit time (MTT) and capillary permeability surface product (CP) maps were obtained. Region of interest analysis was conducted outlining the entire section of the spinal cord. Mann-Whitney test and Spearman’s correlation coefficient were used for statistical analysis. Results were considered statistically significant when p < 0.05.

RESULTS
Spinal cord blood flow, scBF, MTT and CP measurements were not significantly different between patients who did and did not receive RT (N1 = 38) (Figure 1A). There was no significant correlation between perfusion values and age in the pooled data or subgroups. In the small sample of patients evaluated prior to, during and after RT (N2 = 4), scBF and scMTT were respectively increased and decreased on the perfusion study obtained during treatment compared to the baseline and post-RT studies (Figure 1B), and also compared to perfusion values observed in the N1 group. Given the small sample size, statistical analysis was not conducted on the N2 group.

CONCLUSION
CT perfusion can be used to assess spinal cord hemodynamics. In our series spinal cord perfusion parameters were not significantly different between patients who did and did not receive RT of the head and neck. Radiation therapy of the head and neck malignancies may cause transient perturbations of spinal cord perfusion that seem to reverse after treatment.

KEY WORDS: Spinal cord, CT perfusion, radiation therapy
Multidetector CT Angiography of Spinal Vascular Lesions: Initial Experience

Gandhi, D.1 · Ansari, S.1 · Thompson, B. G.1 · Ruiz, D. S. M.2 · Murphy, K.2
1University of Michigan, Ann Arbor, MI, 2Johns Hopkins Hospital, Baltimore, MD

PURPOSE
The purpose of this work was to study and report on the initial experience with multidetector row CT angiography in the evaluation of spinal vascular abnormalities.

MATERIALS & METHODS
Nine patients with suspicion of spinal vascular abnormalities were investigated with 64-slice multidetector row CT angiography (n=8) or a newly FDA-approved 320-slice system (n=1). While a standard first-pass contrast-enhanced CT angiography was obtained in eight patients, one patient underwent a dynamic triphasic evaluation on 320-slice system. Contrast-enhanced MR angiography was performed additionally in six patients. Eight of the nine patients underwent correlative digital subtraction angiography. The level and the size of feeder vessels to the vascular lesions were compared on CTA, MRA and DSA studies by two interventional neuroradiologists.

RESULTS
Amongst the nine lesions, there were six dural arteriovenous fistulas (Type I), two glomus spinal cord arteriovenous malformations (Type II) and one capillary hemangiendothelioma of cervical spine. Precise localization of the feeding radicular vessels and draining veins was possible in seven out of nine patients. In the remaining two, the presence of fistula was confirmed by demonstration of dilated medullary venous plexus but the exact level of fistula could not be determined. In five patients, CTA was rated better than MRA for the depiction of feeding radicular vessels, draining veins and bony anatomy for surgical planning.

CONCLUSION
Multidetector row CT angiography reliably detects spinal vascular malformations and helps with precise classification of these lesions. In our initial experience, CTA appears to be better than spine MRA because of its superior spatial resolution. It also aids in the surgical planning by additionally demonstrating the soft tissue details and bony landmarks. Recently FDA-approved 320-slice CT (Aquilion One, Toshiba) also provides an ability to study the hemodynamics of spinal dural AV fistula.

KEY WORDS: CT angiography, spine, dural AVF

MR Neurography of Neurologic Thoracic Outlet Syndrome

Lee, B. C. · Gillum, L. · Barbaro, N. · Engstrom, J. · Chin, C.
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San Francisco, CA

PURPOSE
Thoracic outlet syndrome (TOS) is a broad term used to describe upper extremity symptoms that may be the result of neurologic and/or vascular compression at the cervicothoracic-brachial junction. Symptoms include pain, parasthesias, and/or muscle wasting. MR imaging of the brachial plexus in this region has been described as a potential diagnostic tool. MR neurography (MRN) is a sensitive technique for demonstrating normal and abnormal nerves. The purpose of our study is to assess the value of MRN in patients with neurologic TOS at our institution.

MATERIALS & METHODS
Retrospective analysis of 20 patients with suspected neurologic TOS referred by neurologists, neurosurgeons, and vascular surgeons for MRN from July 2002 to June 2007. The group comprised of eight females (ages 27-76 years, mean 45.1) and 12 males (ages 20-64 years, mean 44.3). MR neurography was performed on either a Philips or General Electric (GE) 1.5 magnet: Coronal and axial inversion recovery sequences (Philips: TR/TE2200-4750/20-6, TI 160-170, FOV160-180; GE: TR 3367-7867/30-73, TI 150-180, FOV 100-180), T1-weighted coronal and axial images (Philips: TR/TE 465-700/12-14, FOV 160-180). Images were acquired using a neuroradiologist blinded to the electrodiagnostic data and clinical examination and were assessed for signal intensity, size asymmetry, and deviation of the normal course through the thoracic outlet. We also evaluated for anatomical anomalies including cervical ribs, fibromuscular bands, and aberrations of the scalene muscles. Clinical history, examination, electromyography and surgical findings. MR neurography findings were correlated with available electromyography (EMG) and surgical findings.

RESULTS
Eleven patients had abnormal signal involving portions of the brachial plexus on the symptomatic side; six had enlarged nerve roots, trunks, and/or cords on the affected side; seven demonstrated irregular or deviated course of portions of the plexus; five had bony/vertebral abnormalities; one patient had a prominent anterior scalene muscle. Of note, all the abnormalities were found on the affected side, although two patients had bilateral TOS with abnormalities only seen on one side. Six patients had normal MRN exams. EMG studies were available for 10 patients, of which five were normal, four correlated with the side of symptoms, and one was inconclusive. Two patients underwent surgery confirming MRN findings: one patient had a fibromuscular band and the second patient had an anomalous middle scalene insertion compressing the right lower trunk. Both surgical patients had postoperative clinical improvement. One of the patients had a post-surgical MRN which demonstrated normalization of the course of the brachial plexus.
CONCLUSION
Thoracic outlet syndrome continues to be a difficult diagnosis and may require multiple modalities in addition to clinical findings. MR neurography may be a useful adjunct as it can demonstrate abnormal nerve signal reflecting perineural/intra-neural edema related to compression; as well as abnormal morphology and course of the various portions of the brachial plexus. Bony, fibrous and muscular anomalies also can be detected. The combination of MRN findings in conjunction with other studies may lead to a more confident diagnosis.

KEY WORDS: Neurography, thoracic, outlet

Paper 358 Starting at 11:20 AM, Ending at 11:28 AM

Accuracy of Detecting Pedicle Screw Loosening Using Plain X-Ray

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Conquest Hospital
Hastings, UNITED KINGDOM

PURPOSE
In this study, we report interobserver reliability of x-ray for the interpretation of pedicle screw osteointegration based on the diagnosis of “Halo zone” surrounding the screw. Dynamic stabilization system for the spine relies on titanium screw purchase within the pedicle. Decision on osteointegration is important especially when the patient becomes symptomatic following initial good outcome. From our cohort of 420 Dynesys patients, over-all incidence of screw loosening was 17%. Only 35% were symptomatic.

MATERIALS & METHODS
Lumbar spine x-ray images of 50 patients in two views (AP and lateral) randomly selected from our cohort of 420 Dynesys patients. The images were deployed in a CD-ROM. The authors were asked to review the images and state whether or not each pedicle screw is loose (total of 258 pedicle screws). Seven observers composed of two expert orthopedic spine consultant surgeons and one spine expert consultant radiologist and four specialist registrars in orthopedics and radiology. Data gathered were distributed and presented in tables in the form of descriptive statistics. The evaluation of interobserver agreement was performed by obtaining a Kappa (K) index. For continuous variables comparison, the t test was employed, with a significance level of 0.05. Percentage of Kappa index for pedicle screw loosening.

RESULTS
Percentage of Kappa index for pedicle screw loosening.

<table>
<thead>
<tr>
<th>Kappa/ CI</th>
<th>3 Experts</th>
<th>3 Experts &amp; 4 SpR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kappa Index</td>
<td>0.2198</td>
<td>0.1462</td>
</tr>
<tr>
<td>95% confidence interval</td>
<td>CI (-0.0520, 0.4916)</td>
<td>CI (0.0332, 0.2592)</td>
</tr>
</tbody>
</table>

CONCLUSION
Kappa index among expert assessors was 0.2 which means x-ray is unreliable for the assessment of pedicle screw osteointegration. Validity of x-ray is not applicable as it is unreliable. We are planning to evaluate a 3D computer reconstruction model based on 2 x-ray views at 45 degree angle to each other which might be sensitive to detect screw loosening.

KEY WORDS: Pedicle screw, Dynesys, lumbar spine

Paper 359 Starting at 11:28 AM, Ending at 11:36 AM

Dural Ectasia in Marfan Syndrome: A Case Control Study

Lundby, R.1,4 · Rand-Hendriksen, S.2 · Skaur, S.3 · Lilleås, F. G.1 · Prupp, A. H.1 · Smith, H.1,4 · Hald, J. K.4
1University of Oslo, Oslo, NORWAY, 2Sunnas Rehabilitation Hospital, Nesoddtangen, NORWAY, 3Curato, Oslo, NORWAY, 4Rikshospitalet University Hospital, Oslo, NORWAY

PURPOSE
Marfan syndrome (MFS) is a hereditary connective tissue disorder involving several organ systems. The diagnosis should be based upon the Gent criteria. Dural ectasia (DE) is one of the major criteria for MFS, but no gold standard for the assessment of DE exists, and this may contribute to the widely differing prevalences of DE between different reports. The purpose of this study was to establish the prevalence of DE in an adult population of patients fulfilling the Gent criteria for MFS.

MATERIALS & METHODS
A case control study was approved by the local ethics committee. One hundred five adult patients with suspected MFS were included. MR imaging at 1.5 T including sagittal T1- and T2-weighted images, was performed unless contraindicated, when CT was obtained instead. Anteroposterior vertebral body diameter (VBD) and dural sac diameter (DSD) at midcereus level of L3, L4, L5, and S1 were measured on sagittal MR images perpendicular to the long axes of the vertebral bodies. Dural sac ratios (DSR = DSD/VBD) were calculated. Scalloping, anterior meningoceles and herniations of the nerve root sleeves were characterized. One hundred one sex- and age-matched patients without MFS or disease of the lumbosacral spine, examined with MRI at 1.5 T, including sagittal T1- and T2-weighted images were included as controls.

RESULTS
Three patient groups and one control group were identified (Table): (1) Fulfilling Gent criteria independent of DE (n=73), (2) Fulfilling Gent dependent on DE (n=14), (3) Suspected MFS, not fulfilling Gent (n=18), and (4) Controls (n=101). At every level mean DSRs were significantly higher in Gent positive patients than in suspected MFS patients not fulfilling Gent criteria (group 3), and controls (p < 0.001). Herniations of the nerve root sleeves were present at one or more levels in 73% in group 1, 71% in group 2, 11% in group 3, and 1% in group 4. Anterior meningoceles were found in 37% in group 1 and 14% in group 2. There were no meningoceles in group 3 and 4.

Table. DSRs at level L3 - S1 in four different patient groups. At each level, difference in annotation (a-c) indicates statistically significant difference. DE: dural ectasia.

<table>
<thead>
<tr>
<th>Level</th>
<th>n</th>
<th>Mean DSR</th>
<th>SD</th>
<th>n</th>
<th>Mean DSR</th>
<th>SD</th>
<th>n</th>
<th>Mean DSR</th>
<th>SD</th>
<th>n</th>
<th>Mean DSR</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3</td>
<td>69</td>
<td>0.507</td>
<td>0.11</td>
<td>14</td>
<td>0.43</td>
<td>0.08</td>
<td>18</td>
<td>0.45</td>
<td>0.08</td>
<td>101</td>
<td>0.40</td>
<td>0.07</td>
</tr>
<tr>
<td>L4</td>
<td>71</td>
<td>0.50</td>
<td>0.12</td>
<td>15</td>
<td>0.30</td>
<td>0.05</td>
<td>18</td>
<td>0.45</td>
<td>0.06</td>
<td>96</td>
<td>0.43</td>
<td>0.07</td>
</tr>
<tr>
<td>L5</td>
<td>68</td>
<td>0.57</td>
<td>0.18</td>
<td>14</td>
<td>0.65</td>
<td>0.2</td>
<td>18</td>
<td>0.45</td>
<td>0.09</td>
<td>101</td>
<td>0.42</td>
<td>0.08</td>
</tr>
<tr>
<td>S1</td>
<td>61</td>
<td>0.65</td>
<td>0.2</td>
<td>13</td>
<td>1.02</td>
<td>0.77</td>
<td>12</td>
<td>0.40</td>
<td>0.12</td>
<td>96</td>
<td>0.41</td>
<td>0.13</td>
</tr>
</tbody>
</table>

CONCLUSION
Dural ectasia was found in 89% of patients fulfilling the Gent criteria independent of the major criterion DE. MR
imaging of the spine is encouraged to identify MFS patients dependent on DE to fulfill the Gent criteria. Herniation of dura through the nerve root sleeve is one of the most frequent pathologic findings in DE.

**REFERENCES**


**KEY WORDS:** Marfan syndrome, meninges, spine

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**Paper 360 Starting at 11:36 AM, Ending at 11:41 AM**

**Neurolymphomatosis of the Cauda Equina as a First Manifestation of Non-Hodgkin Lymphoma**

van den Hauwe, L.1,2 · Ceyssens, S.2 · Geens, K.1 · Van Goethem, J. W.1,2 · Parizel, P. M.2

1 Az Klina, Brasschaat, BELGIUM, 2Antwerp University Hospital, Antwerp, BELGIUM

**PURPOSE**

Neurolymphomatosis (NL) is a lymphomatous infiltration of peripheral nerves, nerve root/plexus, or cranial nerves. It is a rare condition and may be the first and only manifestation of non-Hodgkin lymphoma. Diagnosis is often difficult since MR imaging may reveal subtle only abnormalities (mild thickening and diffuse enhancement of nerve roots), and nerve biopsies may be inconclusive. 18-F-Fluoro-deoxyglucose (FDG)-positron emission tomography (PET) CT however is a very sensitive technique in establishing the diagnosis, in demonstrating the extent of the disease and in assessing the response to therapy. We report a patient with cauda equina NL as the first manifestation of non-Hodgkin lymphoma.

**CASE REPORT**

A 79-year-old man presented with progressive limping of the left foot and sporadic pain in the left groin. He was admitted to the hospital because of sphincteric disturbances. On clinical examination, a drop foot at the left side was observed. Laboratory findings showed an elevated erythrocyte sedimentation rate and lymphocytosis. Initial CSF analysis revealed an elevated protein and a slightly increased lymphocytosis. Initial CSF analysis showed an elevated protein and a slightly increased lymphocytosis. Flow cytometric immunophenotyping was able to show the presence of abnormal CD10 positive lymphocytes indicating the presence of lymphoma. Neurologic symptoms improved follow-

**IMAGING FINDINGS**

MR imaging of the lumbar spine displayed thickening and enhancement of the nerve roots of the cauda equina, which was more pronounced at the left side. These findings were interpreted as infectious/inflammatory changes. MR imaging of the brain, CT of the chest and abdomen could not demonstrate any mass lesion. On PET CT, an intense FDG-uptake suspect for malignancy of the cauda equina was seen, stretching out along the left L3 and L4 nerve roots. A diagnosis of NL of the cauda equina was proposed. Biopsy of the left L3 nerve was performed; pathology revealed no abnormalities. Final CSF analysis showed an elevated protein and a slightly increased lymphocytosis. Flow cytometric immunophenotyping was able to show the presence of abnormal CD10 positive lymphocytes indicating the presence of lymphoma. Neurologic symptoms improved follow-

**SUMMARY**

Neurolymphomatosis of the cauda equina as a first manifestation of non-Hogkin is a very rare condition. MR imaging may demonstrate a specific thickening and enhancement of the nerve roots. PET CT better shows the extent of the nerve root infiltration and may be useful in guiding the biopsy and in assessing the response to therapy.

**KEY WORDS:** Neurolymphomatosis, lymphoma

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**Paper 361 Starting at 11:41 AM, Ending at 11:46 AM**

**Extensive Calcifications in Spinal Cord Ganglioglioma with T1 Shortening and Magnetic Susceptibility**

Gafton, A. R.1 · Tseng, M. H.1 · Tishkoff, N. W.1,2 · Gorelick, J. L.1,2 · Goodrich, I.1,2 · Gahbauer, H. W.1,2

1Hospital of Saint Raphael, New Haven, CT, 2Yale University School of Medicine, New Haven, CT

**PURPOSE**

To describe MR imaging findings in a rare case of thoracic intramedullary ganglioglioma with unusual extensive macroscopic intratumoral calcifications. Pitfalls of MR imaging, as well as CT findings, differential diagnosis and histopathology also will be discussed.

**CASE REPORT**

A 22-year-old male presented with 2-year history of progressive lower extremity weakness, mild thoracic pain, post-traumatic limping for the past 10 months, and episodic urinary incontinence. Neurologic evaluation identified significant signs of myelopathy, including weakness of the proximal muscles of the left lower extremity, prominent spastic gait, ankle clonus and left Babinski sign.

**IMAGING FINDINGS**

Sagittal T2-weighted image demonstrates a long segment expansile intramedullary mass within the thoracic cord from T4 to T7 with decreased T2 signal, as well as adjacent edema. Increased T2 signal is noted within a second expansile, ill-defined lesion at T9/T10. Postoperative sagittal
reformatted CT image demonstrates dense calcifications within the cord from T4 to T7. Surgical pathology of the upper lesion was consistent with intramedullary ganglioglioma, presumed multifocal.

SUMMARY

There are no pathognomonic MR imaging findings for the rare intramedullary ganglioglioma; the reported cases usually demonstrate mixed T1 signal, high T2 signal, associated tumoral cysts or syrinx, heterogeneous enhancement extending to the cord surface, and occasional areas of hemorrhage. These findings are nonspecific and also can be seen with intramedullary ependymomas or less likely astrocytomas, which rarely calcify. As this case illustrates, T1 shortening and T2 susceptibility may not only represent hemorrhage, but also calcification. CT scan can be a helpful adjunct in further characterization of a spinal cord lesion showing T1 hyperintensity and magnetic susceptibility.

References


KEY WORDS: Ganglioglioma, intramedullary, calcifications

Hemangiopericytoma of the Lumbar Spine: A Unique Presentation of a Rare Entity

Fitzpatrick, D. · Woldenberg, R. · Setton, A. · Lefkowitz, M.
North Shore University Hospital
Manhasset, NY

PURPOSE

To describe the magnetic resonance angiography (MRA) and spinal angiography findings of an unusual hypervascular spinal tumor in association with spinal venous congestion and their relevance to successful endovascular and surgical management.

CASE REPORT

A 54-year-old male presented with acute left lower extremity radiculopathy without myelopathy. Magnetic resonance imaging revealed an intradural lobulated soft tissue mass of the neural foramina bridging the L3-4 and L4-5 levels with prominent spinal cord surface veins without signal change in the spinal cord. Subsequent spinal MRA suggested the presence of dilated spinal veins. Spinal angiography was recommended both to further elucidate the relationship between the soft tissue mass and the abnormal surface veins and for possible preoperative intervention.

IMAGING FINDINGS

Late-phase spinal angiography (left image) revealed an enlarged posterior division of the left L4 lumbar artery with multiple small vessels feeding an oval-shaped elongated hypervascular mass in the left L4 recess (thin black arrows). Radicular venous drainage was present (curved arrows), with filling of congested intradural veins ascending to the level of the conus where congested anterior and posterior spinal veins were apparent (black arrows). These findings correlated with the prior MRA (right image). Microparticles and a single coil were injected into the penetrating vessels of the hypervascular mass achieving devascularization of the hypervascular tumor bed without residual tumor blush and disappearance of the apparent AV shunting accounting for spinal venous congestion. The patient awoke neurologically intact after the procedure and was transported to the operating room for successful microsurgical resection of the tumor with ligation of the radicular vein to prevent spinal venous hypertension. Pathology revealed the hypervascular mass to be a hemangiopericytoma.
SUMMARY
We present a case of a rare spinal mass, an intradural hemangiopericytoma that presented in a highly unusual fashion with markedly dilated spinal surface veins. Subsequent endovascular treatment of the mass and surgical resection with radicular vein ligation improved the patient’s radiculopathy and allowed for resolution of spinal venous congestion, thus avoiding the potential complication of myelopathy.

REFERENCES

KEY WORDS: Hemangiopericytoma

Paper 363 Starting at 11:51 AM, Ending at 11:56 AM
Rare, Bizarre Case of Spinal Intramedullary Osteosarcoma
Deib, G. · Munusamy, S. · Porter, N. · Gillespie, J. · Pal, P. · Holland, J.
Hope Hospital
Manchester, UNITED KINGDOM

PURPOSE
The authors describe a very rare, bizarre case of intramedullary spinal osteosarcoma in a 77-year-old woman which has never been described in the literature.

CASE REPORT
A 77-year-old woman with a history of childhood meningitis presented to the neurosurgical department with a 12-month history of increasing lower back pain and weakness in both legs. Recent sphincteric dysfunction also was described. Neurologic examination revealed bilateral lower limb diminished power and pinprick sensation in the L3 to S1 dermatomes. Numerous previous MRI scans had revealed multiple intra and extramedullary cystic collections which were thought to be secondary to multiple previous lumbar punctures. The patient had a previous cystic decompression.

IMAGING FINDINGS
An MRI scan was ordered which revealed multiple, heterogenously enhancing soft tissue areas within the cord at T10, T12, L1 and L2/3 levels lying predominantly posterior to the previously seen cystic areas. In addition, there were multiple low signal areas in keeping with blood products.
immunohistochemical analysis were in keeping with an intramedullary osteosarcoma. This was later confirmed on histologic assessment of surgical resection (which was done to prevent further contiguous spread of the tumor). The possibility of this tumor being secondary to inflammation, myelograms and/or intrathecal antibiotics was discussed.

**SUMMARY**

An intramedullary spinal osteogenic sarcoma has never been described in the literature. We present this unusual case with pathologic correlation.

**KEY WORDS:** Intramedullary, osteosarcoma, spine tumor

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**Paper 364 Starting at 11:56 AM, Ending at 12:01 PM**

**Aberrant Stent Location in the Epidural Space after Iliac Vein Stenting: Case Report**

Supersin, E. P.† · Nguyen, J. V. † · Vea, R. G. † · Cacayorin, E. D. † · Sitton, C. W. †

†University of Texas Medical School at Houston, Houston, TX, †Louisiana State University, Shreveport, LA

**PURPOSE**

We report this exceedingly rare case of aberrant stent location in the epidural space in a patient previously treated with deep venous thrombosis (DVT) and iliac vein stenting for presumed symptomatic May-Thurner syndrome. In our extensive literature search, we failed to find a case similar to this.

**CASE REPORT**

A 27-year-old woman was referred to our institution for further management of “stent migration”. The patient was treated previously at an outside facility for DVT with placement of a filter in the inferior vena cava (IVC). After placement of IVC filter, the patient then was noted to have focal stenosis of the left iliac vein. It was thought at that time that the patient may have had May-Thurner syndrome. May-Thurner syndrome is regarded as a variant anatomical condition wherein there is focal narrowing of the left iliac vein due to compressive effect exerted by the overlying right iliac artery. Stenting of the left iliac vein subsequently was undertaken but the stent reportedly migrated, hence the referral to our institution. In the outside facility, it was theorized that because the inferior vena cava was obstructed proximally by thrombotic involvement from DVT, the epidural venous collaterals were dilated as a result, paving the way for stent migration. At our institution, the patient was admitted initially under the service of vascular surgery, but subsequently referred to neurosurgery for further evaluation. The patient described her symptoms of bilateral lower extremity weakness, pain, and burning sensation. After clinical evaluation and review of the imaging findings, no surgical intervention was pursued and the patient was referred for rehabilitation.

**IMAGING FINDINGS**

A myelogram was performed which confirmed the location of the previously placed venous stent within the ventral epidural space (Figure). The postmyelogram CT showed the stent in the epidural vein extending from the right lateral recess of L4/L5 to the left neuroforamina of L5/S1 with the-sac and nerve root compression and spinal stenosis at these levels.

**CONCLUSION**

Epidural collaterals may be large and significant in the setting of chronic IVC and/or iliac vein thrombosis. Particular attention to this anatomy is crucial in the placement of venous stents.

**KEY WORDS:** Stent in epidural space, May-Thurner syndrome, deep venous thrombosis

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**Paper 365 Starting at 12:01 PM, Ending at 12:06 PM**

**Rapidly Developing Spinal Epidural Lipomatosis in an HIV-Positive Patient**

Chandler, A. W. · Hart, B. L. · Lloyd, D. K. · Thornton, K. A. · Hayek, R.

University of New Mexico Health Sciences Center Albuquerque, NM

**PURPOSE**

To describe a case of spinal epidural lipomatosis (SEL) which developed in an HIV-positive patient over a brief period of time.

**CASE REPORT**

The patient is a 48-year-old male with HIV, treated with multiple antiretroviral agents including protease inhibitors. He has a history of back pain treated with narcotics. In July of 2007, patient had a lumbar spine MRI which demonstrated minimal disease. A physician performed an epidural steroid injection. The patient continued to have pain and became nonambulatory at an assisted-living facility. Examination revealed bilateral lower extremity weakness, pain, and hyperreflexia. Repeat MRI was performed.

**IMAGING FINDINGS**

Repeat MRI demonstrated interval development of SEL since the comparison examination 4 months previously.
Spinal epidural lipomatosis resulted in spinal canal stenosis at L4-5 and L5-S1. There was also marked increase in subcutaneous and intraabdominal fat.

**SUMMARY**

Spinal epidural lipomatosis is a rare condition characterized by the accumulation of fat within the epidural space of the spinal canal. Most cases have been linked to Cushing syndrome from long-term exogenous steroid administration. Rare cases have been described in patients receiving multiple epidural steroid injections. The etiology in this case may be multifactorial. The patient gained 40 pounds over 4 months following transfer to an assisted-living facility. This weight gain was likely due to both improved nutrition and increased compliance with his medication regimen. Three cases of SEL have been described in patients treated with steroids and protease-inhibitors (PI) for HIV. Lipodystrophy is a known adverse effect of PI therapy resulting in redistribution of fat from peripheral tissues such as the extremities to central areas of the body resulting in truncal obesity. It is, as of yet, unclear if lipodystrophy associated with PIs may be responsible for SEL. In this case, SEL was likely the result of both PI therapy and rapid weight gain.

**KEY WORDS:** Spinal epidural pipomatosis, HIV lipodystrophy

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**Paper 366 Starting at 12:06 PM, Ending at 12:11 PM**

**Cervical Osteochondroma in a 33-Year-Old Female with Symptoms of Dizziness and Vertigo on Head Turning: Bowhunter Syndrome**

Short, J. H. · Maya, M. · Moser, F. G. · Pressman, B. D.
Cedars-Sinai Medical Center
Los Angeles, CA

**PURPOSE**

We present the imaging findings in a patient with bowhunter syndrome (symptomatic occlusion of the vertebral artery upon rotation of the head).

**CASE REPORT**

A 33 year-old female with a history of headache and back pain presented with symptoms of vertebral artery occlusion on turning of the head to the right. A CT angiogram of the neck demonstrated a dominant right vertebral artery and a bony lesion adjacent to the right C3 vertebral body and right vertebral artery. The patient had an angiogram of the right vertebral body including test balloon occlusion. The angiogram demonstrated kinking of the right vertebral artery upon turning the head to the right; the patient failed a balloon occlusion test. The lesion subsequently was resected without sacrifice of the ipsilateral vertebral artery and proved to be an osteochondroma.

**IMAGING FINDINGS**

CT angiogram of the neck shows a bony lesion between the transverse foramina of the right C3 and C4 vertebral bodies, as well as a dominant right vertebral artery. An angiogram of the right vertebral artery with the head turned to the right shows a kink of the right vertebral artery at the level of the lesion.
SUMMARY
Osteochondromas are thought to comprise approximately 8% of bone tumors and 35% of all bone tumors; most present before the age of 20. Most occur in the long bones; nearly half are found in the distal femur or proximal tibia. Only 1-4% are seen in the spine; bowhunter syndrome in association with cervical osteochondroma has not been reported previously.

KEY WORDS: Osteochondroma, vertebrobasilar, angiogram

Thursday Morning
10:30 AM – 12:15 PM
Room 206/207

(54b) INTERVENTIONAL:
Aneurysms II
(Scientific Papers 367 – 379)

See also Parallel Sessions
(54a) SPINE: Spinal Cord, Neoplasms & Other/Excerpta
(54c) ADULT BRAIN: Miscellaneous
(54d) ADULT BRAIN: New Techniques & Postprocessing

Moderators: Joshua A. Hirsch, MD

Paper 367 Starting at 10:30 AM, Ending at 10:38 AM
Late Midterm Results of a Multicenter Prospective Long-Term Coil Embolization Study

Hirsch, J. A.
Massachusetts General Hospital
BOSTON, MA

PURPOSE
To design and set up an electronic data base with longitudinal information on the use of bare platinum coils for the endovascular occlusion of cerebral aneurysms. We report a late midterm analysis of the existing data.

MATERIALS & METHODS
From May 1, 2004 to July 10, 2007, 303 patients with 322 aneurysms, ruptured or unruptured, were enrolled into a global registry study from 36 centers in the United States, Europe, and Latin America, to be treated with bare detachable platinum coils (mostly Trufill DCS Orbit™ coils) of various sizes, shapes, and grades of softness. Acute as well as long-term anatomical and clinical data were collected and evaluated. Target enrollment is 500 patients worldwide.

RESULTS
A total of 313 aneurysms in 303 patients were treated. Mean packing density was 31.1%, which was further analyzed using the following subsets: balloon remodeling, stent for vascular reconstruction, ruptured/unruptured aneurysms, and correlated to aneurysm volume. Adjunctive techniques were used in 29.9% of patients. Stability was analyzed by correlating follow up to initial occlusion, aneurysm location, and ruptured/unruptured aneurysm status at initial treatment. Device-related adverse events were reported in 9 (3.0%) patients and procedural complications related to the device in 10 (3.3%).
with 10 unrelated deaths. Eleven (6.2%) of the 178 aneurysms evaluated at follow up were retreated. No aneurysms were retreated as a result of hemorrhage or rehemorrhage.

**Conclusion**
This database is an important information gathering tool for the endovascular treatment of cerebral aneurysms, demonstrating that the use of bare platinum detachable coils allows favorable rates of initial complete obliteration, packing density, and stability at follow up of up to 2 years, especially in small aneurysms. This late midterm analysis is a fundamental step in sifting through the extensive amount of data available within this cohort of patients. Additional study, including multiple subset analyses, will help to define further the role of endovascular coiling in various types of patients with various types of aneurysms, as well as determine the lasting stability of aneurysmal occlusion.

**Key Words:** Cerebral aneurysms, coil embolization

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**Paper 368 Starting at 10:38 AM, Ending at 10:46 AM**

**Recovery of Posterior Communicating Artery Aneurysm-Induced Oculomotor Palsy after Coiling**

Peluso, J. P. P. · van Rooij, W. · Sluzewski, M.
St Elisabeth Ziekenhuis
Tilburg, THE NETHERLANDS

**Purpose**
Recovery of oculomotor (CN III) palsy after surgery of posterior communicating artery (PcomA) aneurysms has been well documented but recovery after coiling is poorly understood. In this study, we report the recovery after coiling of PcomA aneurysm-induced CN III palsy in 21 patients at follow up of 1-7 years.

**Materials & Methods**
Of 135 patients with a PcomA aneurysm treated with coils between January 1997 and December 2003, 21 patients with initial CN III dysfunction were selected and reevaluated. There were two men and nineteen women with a mean age of 54.9 years. In 17 patients CN III palsy was associated with subarachnoid hemorrhage. Timing of treatment after onset of symptoms was 1-3 days in five, 4-14 days in 13 and >14 days in three patients. Mean aneurysm size was 9 mm. Initial CN III palsy was complete in 15 and partial in six patients. Follow up after coiling was mean 3.7 years (range 1-7 years).

**Results**
Of 15 patients with initial complete CN III palsy, recovery was complete in three and partial in 10. In two patients, complete CN III palsy was unchanged. Of six patients with initial partial CN III palsy, recovery was complete in five and partial in one. Initial partial CN III palsy was the only predictor of complete recovery at follow up.

**Conclusion**
PcomA aneurysm-induced CN III palsy improves or cures after coiling in the vast majority of patients. Complete recovery is more likely with initial partial nerve dysfunction.

**Key Words:** Posterior communicating artery, aneurysm, oculomotor nerve palsy

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**Paper 369 Starting at 10:46 AM, Ending at 10:54 AM**

**Additional Value of 3D Rotational Angiography in Angiogram Negative Aneurysmal Subarachnoid Hemorrhage: How Negative is Negative?**

Peluso, J. P. P. · van Rooij, W. · Sluzewski, M.
St Elisabeth Ziekenhuis
Tilburg, THE NETHERLANDS

**Purpose**
In some patients with nonperimesencephalic nontraumatic subarachnoid hemorrhage (aneurysmal SAH) no aneurysm can be found on digital subtraction angiography (DSA) and repeat DSA is advocated. 3D rotational angiography (3D RA) is considered superior to DSA in detection of small intracranial aneurysms. In this study, we assess the additional diagnostic value of 3D RA in detecting DSA occult aneurysms in 23 patients with aneurysmal SAH.

**Materials & Methods**
Between January 2006 and September 2007, 298 patients with suspected ruptured intracranial aneurysm were referred for DSA and in 98 patients DSA was negative. Of these 98 patients, 28 had aneurysmal SAH and in 23 additional 3D RA was performed in the same or in a repeat angiographic procedure.

**Results**
In 18 of 23 patients (78%) a ruptured small aneurysm was diagnosed on additional 3D RA. Location of 18 aneurysms was anterior communicating artery 11, middle cerebral artery three, posterior communicating artery two, ophthalmic artery one and posterior inferior cerebellar artery one. Aneurysm size was 3 mm in four, 2 mm in nine and 1 mm in five. Of 18 aneurysms, nine were treated with coil placement, seven with surgical clipping and two were not treated.

**Conclusion**
In the vast majority of patients with angiogram negative aneurysmal SAH, additional 3D RA detects a small treatable ruptured DSA occult aneurysm, mostly located on the anterior communicating artery.

**Key Words:** Aneurysmal SAH, occult aneurysms, 3D angiography

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**Paper 370 Starting at 10:54 AM, Ending at 11:02 AM**

**Measuring the Limits of Aneurysm Size Discrimination**

Reilley, M. J. · Mamourian, A. C. · Wishart, H. A. · Osborne, T. F.
1Dartmouth Medical School, Hanover, NH, 2University of Pennsylvania Health System, Philadelphia, PA, 3Dartmouth-Hitchcock Medical Center, Lebanon, NH

**Purpose**
With current thinking about the natural history of small anterior circulation aneurysms, follow-up imaging is sometimes preferred over immediate treatment (1). There is no documented evidence, however, that measures the ability of imagers to recognize small difference in aneurysm size. In
this study, we tested the ability of imagers to recognize small size differences in spherical objects. The primary goals were to: 1) Find the smallest difference in objects that can be identified reliably; 2) Measure how confidence relates to accuracy.

MATERIALS & METHODS
The test was presented on a computer and consisted of 100 pairs of images in 2 parts. Part 1 included 50 pairs of idealized spheres with as much as a 20% difference in diameter (73% volume). Part 2 included 50 random pairs of surface models of a phantom aneurysm from CTA type images with a 28% range in diameter (110% volume). The test was administered to a total of 15 subjects in three groups (neuroradiologists, radiology residents, and medical students) of five. We sought to include individuals of similar intelligence, but at different levels of experience with neuroradiology. Subjects were asked to compare the pairs of spherical images and rate on continuous scales any perceived size difference, including magnitude, and their confidence level.

RESULTS
In part 1, all participants reached 100% accuracy in identifying the larger sphere at or above a 7.5% diameter (22% volume) difference with 80% average confidence in their answers. Confidence reached a peak of 90% at a 10% difference, while accuracy remained 100%. In part 2, 100% accuracy was reached only at a 15% diameter (59% volume) difference with a 90% average confidence. The highest accuracy was achieved with large differences between the images as expected. The relationship between accuracy and size difference was “J-shaped” with the lowest accuracy occurring in images with the smallest difference between them.

CONCLUSION
Our findings suggest a relatively large size difference is necessary for high interobserver accuracy. Interestingly, perfect accuracy in both parts was achieved prior to peak confidence. We found participants were less accurate and confident when identifying small size differences as opposed to equal sized objects. The subjects required a larger size difference in part 2, using a more complex shape, to achieve comparable levels of accuracy. Part 2 more closely replicates the task of clinical imaging and it seems reasonable to predict that with complex aneurysm shapes up to a 59% change in volume may go unrecognized. This has important implications with regard to accuracy of aneurysm follow up for size change.

REFERENCES

KEY WORDS: Aneurysm, Size discrimination

Paper 371 Starting at 11:02 AM, Ending at 11:10 AM

Recruitment of Patients for the TEAM Study (Trial on Endovascular Aneurysm Management): An Achievable Goal

Audet, M. E. · Raymond, J. · Roy, D. · Guilbert, F. · Chew, J. B. · Weill, A.
Centre Hospitalier de l’Université de Montréal
Montreal, QC, CANADA

PURPOSE
To determine the recruitment rate for the TEAM study at our institution in order to estimate the clinical feasibility of the study.

MATERIALS & METHODS
Retrospective study of all the outpatient consultations from the beginning of recruitment in TEAM (June 2006) to October 2007. All consultations for unruptured aneurysms were reviewed including patients presenting with subarachnoid hemorrhage with good recovery and harboring one or more additional unruptured aneurysms.

RESULTS
We found 188 patients with at least one unruptured aneurysm. One hundred and thirteen (113) patients fulfilled the inclusion criteria of the TEAM study. The attending physician did not offer participation to 51 of these (45%) patients for various reasons (27 were treated and 24 were observed). Participation in the study was proposed to 62 patients (55%) and 11 of these (18%) accepted. Thirty-five patients refused to participate (21 chose to be treated and 14 chose surveillance). Sixteen patients never informed us of their decision. One of these patients died from rupture of her aneurysm 2 months after study was proposed.

CONCLUSION
At our institution, 18% of patients to whom the TEAM study was proposed accepted participation. A significant number of patients deferred their decision and did not contact us again. A systematic follow-up appointment may be a solution in order to improve patient enrollment.

* TEAM is funded by the Canadian Institutes of Health Research (http://www.cihr-irsc.qc.ca) and is registered: International Standard Randomized Controlled Trial Number (ISRCTN62758344) (www.controlled-trials.com)

KEY WORDS: Unruptured aneurysm, endovascular, treatment

Thursday
Relationship between Occurrence of Irregular Aneurysm and Different Position of Inflated Balloon during Creation of Elastase-Induced Aneurysms: A Retrospective Study

Ding, Y. · Kadirvel, R. · Dai, D. · Lewis, D. · Cloft, H. J. · Kallmes, D. F.

Mayo Clinic
Rochester, MN

PURPOSE
Irregular shape of elastase-induced aneurysms after creation remains to be a challenge for researchers using this model. We tried to explore the relationship between occurrence of irregular aneurysm and different position of inflated balloon during creation of elastase-induced aneurysms in rabbits.

MATERIALS & METHODS
Ninety-eight elastase-induced aneurysms in rabbits were analyzed retrospectively. Two groups were classified according to different position of inflated balloon: Group 1 (n=49), the inflated balloon resided in the right common carotid artery (RCCA) origin and distal brachiocephalic artery, without herniation to the right into the proximal subclavian artery; Group 2 (n=49), in which the balloon occupied the RCCA origin, the distal brachiocephalic artery, and also herniated into the proximal subclavian artery, just distal to the RCCA origin. Digital subtractive angiography (DSA) was performed at least 3 weeks after creation. Irregular aneurysms, defined as multilobulated cavities and/or dilation of the proximal subclavian artery were noted. Occurrence rates of irregular aneurysms between two groups were calculated and compared.

RESULTS
Thirty-four of 49 (69%) aneurysms in Group 1 showed irregular aneurysm (Figure 1). In Group 2, only 3/49 (6%) aneurysms were irregular, with all others showing regular shape (Figure 2). Differences of occurrence rates of irregular aneurysm between two groups were significant (p<.001, Fisher’s Exact Test).

CONCLUSION
Irregular aneurysm shape and dilation of the subclavian artery can be avoided by adjusting balloon inflation when creating elastase induced aneurysms in rabbits.

KEY WORDS: Aneurysm, model, shape
CONCLUSION
(1) The hemodynamics at the ICA terminus bifurcation can significantly alter the hemodynamics within proximal PComm aneurysms. (2) Downstream anatomical configurations that alter arterial resistance, such as hypoplastic A1 or M1 arterial segments can affect proximal aneurysm development, growth and rupture. (3) Attention to outlet boundary conditions is important when performing CFD simulations involving intracranial aneurysms.

KEY WORDS: Aneurysm, computational fluid dynamics, internal carotid artery

Summary of Paper 374

Paper 375 Starting at 11:26 AM, Ending at 11:34 AM

Computational Flow Dynamics Simulations and 4D Phase-Contrast MR Measurements of Flow in Aneurysms: A Comparison Study

Jiang, J. · Johnson, K. M. · Wieben, O. · Strother, C. M.
University of Wisconsin
Madison, WI

PURPOSE
Image-based CFD is increasingly used to model the complex hemodynamic parameters present in human aneurysms (e.g., wall shear stresses and pressure). Although validation of these simulations using phantoms or in vitro models has shown favorable agreement, few studies have been conducted to compare flow patterns derived from CFD with those measured by in vivo PC-MR acquisitions, mostly because of the extended imaging time for volumetric cine PC-MR acquisitions. In this study, we compared CFD results with in vivo velocity measurements in a canine aneurysm model obtained with a novel PC-MR acquisition technique (1).

MATERIALS & METHODS
We investigated three aneurysms in two dogs. Cine data sets of velocity vector field were obtained with volumetric coverage and high spatial and temporal resolution with PC VIPR (1), a novel acquisition technique that allows for dramatic reductions in total scan time by using radial undersampling. In a scan time of 10 min, data sets with isotropic spatial resolution of 0.625 mm and frame durations of 28 ms were achieved over a cubic volume of 16-cm x 16-cm x 16-cm with a clinical 1.5 T system (Signa; GE Healthcare, WI). In the CFD simulations, a commercially available CFD solver (FLUENT 6.2, FLUENT Inc., NH) was used, based on meshed 3D digital subtraction angiographic (3D DSA) data (Simpleware Inc., UK). Flow boundary conditions were established using PC-MR flow imaging. EnSight (CEI Inc., NC) in conjunction with in-house Matlab (Mathworks Inc., MA) routines was used for interactive 4D data analysis and visualization of velocity vector graphs, 3D stream lines, and time-resolved 3D particle traces.

RESULTS
For comparison, cross-sectional planes through aneurysms and parent arteries were chosen for each animal. Cross-sectional axial velocity profiles were compared at 15 time points during the cardiac cycle. Qualitative comparison of 3D axial velocity profiles revealed favorable agreement between simulations and measurements with less than 10% difference in peak velocities. Reasonable correspondence was observed also in aneurysm dome with both approaches showing similar velocity profiles (e.g., velocity coded streamlines [(left) MR and (right) CFD]) (Figure below).

CONCLUSION
Our results show good agreement of the velocity vectors in a dog aneurysm model obtained from the 3D cine PC-MR and from the CFD simulations. In future work we will extend this technique to retrospectively study human intracranial aneurysms.

REFERENCES

KEY WORDS: 4D MR, computational fluid dynamics

Summary of Paper 375

Paper 376 Starting at 11:34 AM, Ending at 11:39 AM

Magnitude and Distribution of Wall Shear Stress in Self-Expanding Intracranial Stents: Open-Cell versus Closed-Cell Design

Ionescu, M. · Metcalfe, R. · Valdivia y Alvarado, M. · Benndorf, G.
The Methodist Hospital Research Institute
Houston, TX

PURPOSE
Intracranial self-expandable stents are used increasingly for treatment of intracranial aneurysms and occlusive diseases.

CONCLUSION
The hemodynamics at the ICA terminus bifurcation can significantly alter the hemodynamics within proximal PComm aneurysms. Downstream anatomical configurations that alter arterial resistance, such as hypoplastic A1 or M1 arterial segments can affect proximal aneurysm development, growth and rupture. Attention to outlet boundary conditions is important when performing CFD simulations involving intracranial aneurysms.

Summary of Paper 376

Paper 377 Starting at 11:39 AM, Ending at 11:44 AM

Computational Flow Dynamics Simulations and 4D Phase-Contrast MR Measurements of Flow in Aneurysms: A Comparison Study

Jiang, J. · Johnson, K. M. · Wieben, O. · Strother, C. M.
University of Wisconsin
Madison, WI

PURPOSE
Image-based CFD is increasingly used to model the complex hemodynamic parameters present in human aneurysms (e.g., wall shear stresses and pressure). Although validation of these simulations using phantoms or in vitro models has shown favorable agreement, few studies have been conducted to compare flow patterns derived from CFD with those measured by in vivo PC-MR acquisitions, mostly because of the extended imaging time for volumetric cine PC-MR acquisitions. In this study, we compared CFD results with in vivo velocity measurements in a canine aneurysm model obtained with a novel PC-MR acquisition technique (1).

MATERIALS & METHODS
We investigated three aneurysms in two dogs. Cine data sets of velocity vector field were obtained with volumetric coverage and high spatial and temporal resolution with PC VIPR (1), a novel acquisition technique that allows for dramatic reductions in total scan time by using radial undersampling. In a scan time of 10 min, data sets with isotropic spatial resolution of 0.625 mm and frame durations of 28 ms were achieved over a cubic volume of 16-cm x 16-cm x 16-cm with a clinical 1.5 T system (Signa; GE Healthcare, WI). In the CFD simulations, a commercially available CFD solver (FLUENT 6.2, FLUENT Inc., NH) was used, based on meshed 3D digital subtraction angiographic (3D DSA) data (Simpleware Inc., UK). Flow boundary conditions were established using PC-MR flow imaging. EnSight (CEI Inc., NC) in conjunction with in-house Matlab (Mathworks Inc., MA) routines was used for interactive 4D data analysis and visualization of velocity vector graphs, 3D stream lines, and time-resolved 3D particle traces.

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CONCLUSION
Our results show good agreement of the velocity vectors in a dog aneurysm model obtained from the 3D cine PC-MR and from the CFD simulations. In future work we will extend this technique to retrospectively study human intracranial aneurysms.

REFERENCES

KEY WORDS: 4D MR, computational fluid dynamics

Summary of Paper 377
Stent thrombosis and in-stent restenosis are major concerns and it is likely that hemodynamic parameters such as wall shear stress (WSS) are involved significantly. The purpose of this study is to investigate the WSS in two different stent types: open-cell and closed cell design, using computational hemodynamics (CHD) simulations (Fluent, Inc., Lebanon, NH). Unlike previously studied idealized models, these simulations included the effects of asymmetry, malapposition, and prolapse associated with real stent deployment.

**Case Report**
A 4x20mm Neuroform stent (NF3) (Boston Scientific, Fremont, CA) and an 4 x 25mm Enterprise Stent (Cordis NeuroEndovascular, Miami Lakes, FL) were deployed in a straight plastic tube and imaged with a high-resolution MicroCT scanner (eXplore Locus SP, GE Healthcare, Milwaukee). Three-dimensional reconstructions were obtained and meshed using a segmentation algorithm Amira (Zuse Institute Berlin, Germany) and mesh generator Gambit (Fluent, Inc., Lebanon, NH).

**Imaging Findings**
Flow velocities and WSS data were obtained with emphasis on the hemodynamics near the stent struts, strut vertices, and imaging markers. Significant deviations from idealized deployment models previously studied were observed. Small recirculation zones with negative WSS were observed near malapposed and misaligned strut vertices, as well as proximal and distal to the stent markers. Prolapsed struts also permitted flow between the strut and the wall, creating larger zones of low WSS. Lower WSS was observed at the centers of the Enterprise than in the cells of the NF3.

**Summary**
Intra-stent flow pattern and WSS distribution is strongly influenced by stent design, strut dimensions as well as cell shape and differs significantly between the two stents tested in this study. Malapposition, strut misalignment and prolapse, occurring more often in open-cell design stents, contribute significantly to the generation of low and negative WSS values. There is evidence that stents with lower profile and smaller cell size are less likely to introduce such potentially deleterious WSS zones.

**References**

**Key Words:** Intracranial stent, flow pattern, wall shear stress
Purpose
In recent years, Guglielmi detachable coils (GDC) have been used increasingly for endovascular treatment of cerebral aneurysms. Several different GDC coils have been developed including coils that create various conformations in an attempt to facilitate treatment of irregular or wide-necked aneurysms as well as to influence the durability of aneurysm occlusion posttreatment. Our objective was to assess immediate and midterm angiographic occlusion of GDC® 360° complex shaped coils compared to 3D and 2D helical GDC coils.

Materials & Methods
Two hundred ninety-one cerebral aneurysms subsequently were treated with GDC coils. One hundred forty-four were treated with GDC 360° coils and the remaining 147 aneurysms were treated with the 3D and 2D helical GDC coil system. All aneurysms were packed until no additional coils could be placed into the aneurysm without catheter displacement or use inordinate force. Initial postprocedural angiograms were compared to first follow-up angiograms (<12 months postprocedure). Second follow-up angiograms occurred more than 12 months after the initial procedure. Occlusion was classified as complete occlusion, neck remnant (filling at aneurysm neck but no room for additional coil), and residual filling (room for additional coils). Balloon remodeling was used in 59% of the cases. Aneurysms greater than 2.5 cm were excluded. Packing density and aneurysm volume also were calculated for each aneurysm.

Results
First and second follow-up angiograms for aneurysms coiled with GDC 360° showed 73% and 71% complete occlusion and helical GDC showed 59% and 53%, respectively. Initially postprocedure, GDC 360° had 72.8% and helical GDC had 59.8% complete occlusion. Helical GDC showed 26% residual filling at first follow up and GDC 360° showed 6% (p-value = .007). The overall recanalization (compaction to residual filling) and retreatment rate is 5.6% and 2.8% for the GDC 360° group and 8.8% and 4.1% for the helical GDC group. Ruptured aneurysms comprised 38% of the GDC 360° and 53% of the helical GDC group. When comparing only ruptured aneurysms of the two coil types, GDC 360° coils continued to show greater complete occlusion (65.71% and 68.75%) compared to helical GDC (46.8% and 41.94%) at first and second follow up. Initially postprocedure, both groups had 62-63% complete occlusion in ruptured aneurysms. The two groups were not statistically different in mean patient age, female to male ratio, and anterior to posterior location distribution of aneurysms. The same angiographic trends were seen when comparing aneurysms coiled with balloon assistance between the groups. Average aneurysm volume was 1.23 cc in the GDC 360° group and 0.84 cc in the helical GDC group. The packing density was 32% in both groups with no statistically significant difference in ruptured and unruptured aneurysms.

Conclusion
The GDC 360° coil system provides similar packing densities and improved angiographic efficacy in both initial postprocedure and subsequent follow-up angiograms compared to a standard GDC helical coil design.

Keywords: Aneurysm, GDC
Table 1. Sidewall Group, GDC treated aneurysm packing densities.

<table>
<thead>
<tr>
<th>Packing Density</th>
<th>Number of Aneurysms</th>
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<tr>
<td>0-10%</td>
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<tr>
<td>11-20%</td>
<td>18</td>
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<tr>
<td>21-30%</td>
<td>24</td>
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<tr>
<td>31-40%</td>
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<td>61-70%</td>
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<td>71-80%</td>
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Table 2. Bifurcation Group, GDC treated aneurysm packing densities.

<table>
<thead>
<tr>
<th>Packing Density</th>
<th>Number of Aneurysms</th>
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<tr>
<td>0-10%</td>
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<tr>
<td>11-20%</td>
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<td>0</td>
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<td>71-80%</td>
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CONCLUSION

Coiling of unruptured, sidewall aneurysms, measuring less than or equal to 10 mm in maximum diameter with bare coils has an excellent outcome with, in our case, zero recanalization rate. This study suggests that packing density is not as important as previously thought as predictor of recurrence for nonruptured side wall aneurysms. However for bifurcation aneurysms packing density appears to play an important role.

KEY WORDS: Aneurysm, coils, GDC

Paper 379 Starting at 12:03 PM, Ending at 12:11 PM

A New Self-Expandable Nitinol Stent for the Treatment of Wide-Necked Aneurysms: Initial Clinical and Angiographic Results in 16 Aneurysms

Peluso, J. P. P. · van Rooij, W. · Sluzewski, M. · Keeren, G.
St. Elisabeth Ziekenhuis
Tilburg, THE NETHERLANDS

PURPOSE

We report the results of a prospective clinical study using a new self expanding nitinol stent (Enterprise) in the treatment of wide necked intracranial aneurysms. The Enterprise stent is delivered through a microcatheter and can be recaptured.

MATERIALS & METHODS

Between January and October 2007, 16 aneurysms in 15 patients were treated with stent assistance. Aneurysm size was mean 13.2 mm (median 12, range 7-30 mm). Six aneurysms had reopened after prior coiling and 10 aneurysms were primarily treated, one after acute SAH. In all patients response to antiplatelet medication was tested with a P2Y12 assay before stent placement. On a 3D angiography workstation, stent placement was simulated to assess vessel caliber and appropriate stent length.

RESULTS

In all aneurysms, the stent could be placed at the exact location as predicted from the computer simulation. Stent placement proved to be technically easy without the need for recapture in all cases. Although placement of the microcatheter through the stent struts and subsequent coil placement was challenging in some cases, coiling after stent placement resulted in complete or near complete aneurysm occlusion in all aneurysms. There were no technical or clinical complications. At 6 months angiographic follow up in 13 aneurysms, 4 aneurysms recanalized to 80% occlusion and 3 of these were additionally coiled.

CONCLUSION

Placement of the new Enterprise stent proved to be technically easy and safe. This stent is a valuable tool in the treatment of wide-necked aneurysms in different locations.

KEY WORDS: Nitinol stent, enterprise, aneurysm

Thursday Morning

10:30 AM – 12:15 PM
Room 208/209

(54c) ADULT BRAIN: Miscellaneous
(Scientific Papers 380 – 393)

See also Parallel Sessions
(54a) SPINE: Spinal Cord, Neoplasms & Other/Excerpta
(54b) INTERVENTIONAL: Aneurysms II
(54d) ADULT BRAIN: New Techniques & Postprocessing

Moderators: Bradley N. Delman, MD
Jeffrey G. Jarvik, MD, MPH

Paper 380 Starting at 10:30 AM, Ending at 10:38 AM

Comparison of Radiation Dose between Standard Sequential and Spiral CT Head Scans

Abdeen, N. · Heddon, G. · Santos, M. · Schwarz, B. · Donaldson, M. · Chakraborty, S.
University of Ottawa
Ottawa, ON, CANADA

PURPOSE

Head CT examinations commonly are performed using a sequential thick slice technique, although thin slice helical acquisition in modern scanners has been shown to yield equivalent or superior image quality. The current study compared the equivalent radiation dose at the eyelid (approximating lens dose) and midline neck (approximating thyroid
dose) in outpatients undergoing head CT scans randomized to either sequential or helical acquisition technique.

**Materials & Methods**

Patients scheduled to undergo routine noncontrast head CT scans were randomized to sequential or helical technique. CT scans were performed on 16-slice (GE Lightspeed Ultra) or 64-slice (GE Lightspeed VCT) scanners. Helical scans were performed at 120 kVp and 300 mA, 0.5s tube rotation, slice thickness 0.625 and pitch ~0.5 (0.531 for the 64 slice and 0.562 for the 16 slice). Sequential scans performed with the 16-slice scanner used 140 kVp, 190 mA, 5 mm slice thickness (posterior fossa) and 120 kVp, 190 mA, 7.5 mm slice thickness (remainder of brain). The corresponding parameters for the 64-slice scanner were 140 kVp, 170 mA, 5 mm slice thickness (posterior fossa) and 120 kVp, 150 mAs, 5 mm slice thickness (remainder of brain). Fourteen patients (7 helical and 7 sequential) were scanned in the helical scanner. Forty patients (21 helical and 19 sequential) were scanned in the 64-slice scanner. Equivalent doses were measured in real time using a MOSFET (metal oxide semiconductor field effect transistor) system. The lens dose was approximated by a MOSFET taped to the eyelid and thyroid dose was approximated by a MOSFET at the level of the cricoid cartilage in the midline. The mean lens and thyroid dose for sequential and helical scans was compared in both the 16- and 64-slice scanners, using Students’ t-test and a significance level of 0.05. Image quality of a standard set of four selected images from each study were rated by two independent observers (blinded to the technique used) on a 5 point scale with respect to each of streak artifact, gray white matter differentiation, noise, and overall quality.

**Results**
The lens dose was significantly higher for the sequential technique compared to the helical technique for the 64-slice scanner (61.5 mGy +/-12.9 mGy vs 43.5 mGy +/-4.3 mGy) and for the 16-slice scanner (75.5mGy +/-16.5 mGy vs 43.5 mGy +/-3.6 mGy). The thyroid dose was not significantly different between helical and sequential scan techniques in the 16-slice scanner (1.6 mGy +/-0.7 mGy vs 1.4 mGy +/-0.6 mGy) or in the 64-slice scanner (1.6 mGy +/-0.5 mGy vs 2.0 mGy +/-0.6 mGy). There was no significant difference in image quality between the two techniques.

**Conclusion**
Helical acquisition of noncontrast head CT scans produces images of equal or better quality to standard sequential technique with approximately 2/3 of the lens dose and equivalent thyroid dose on both 16- and 64-slice scanners. Helical acquisition is preferred to sequential scanning as it permits more stringent adherence to the ALARA principle.

**Key Words:** Radiation dose, CT head, MOSFET
and after sodium imaging at 9.4 T suggest that performing human MRI at 105.92 MHz in a 9.4 T static magnetic field does not pose a readily demonstrable health risk.

**KEY WORDS:** Ultra-high field safety, sodium imaging

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**Paper 382 Starting at 10:46 AM, Ending at 10:54 AM**

**Human 17-Oxygen Imaging at 9.4 T and Enhanced Reconstruction Using 23-Sodium**

Atkinson, I. C.; Lu, A.; Halder, J. P.; Liang, Z.; Thulborn, K. R.

1University of Illinois at Chicago, Chicago, IL, 2University of Illinois at Urbana-Champaign, Urbana, IL

**PURPOSE**

To demonstrate the feasibility of performing natural abundance 17-oxygen (17-O) MRI imaging of the human brain at 9.4 T and illustrate that a constrained reconstruction approach using 23-sodium (23-Na) data provides improved image quality for natural abundance 17-O data.

**MATERIALS & METHODS**

Natural abundance 17-oxygen and 23-sodium MR imaging was performed on a healthy volunteer using the 9.4 T 80 cm MR scanner described in reference 1. Data were acquired using a modified version of the previously reported twisted projection imaging (2) and custom-built, single-tuned quadrature birdcage RF coils. These RF coils can be exchanged rapidly without disturbing the subject, enabling the coregistered acquisitions from different nuclei. Data coregistration is required for constrained reconstruction. After shimming at the sodium frequency to a whole-head linewidth of less than 25 Hz, sodium imaging was performed with an isotropic resolution of 3.125 mm in 6 minutes and 36 seconds. Natural abundance 17-O imaging then was performed with an isotropic spatial resolution of 7 mm in 7 minutes and 50 seconds. The specific absorption rate (SAR) was monitored in real-time during all acquisition and remained within FDA guidelines. Image reconstruction was performed using a conventional 3D gridding approach with a Kaiser-Bessel interpolation kernel. Constrained reconstruction of the 17-O data was performed using the high-resolution sodium data as the constraint (3).

**RESULTS**

The reconstructed sodium and oxygen images are shown in Figure 1, where it can be seen that natural abundance 17-O imaging of the human brain in less than 8 minutes is possible at 9.4 T. The constrained reconstruction illustrates that the intrinsic data quality can be improved upon by incorporating information that can be obtained readily from other nuclei (23-Na in this case). Using an acquisition optimized for time (rather than SNR), whole-brain 17-O imaging can be performed as rapidly as 26 seconds. When combined with constrained reconstruction techniques, this potentially enables near real-time 17-O imaging to be performed in humans.

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**Figure 1.** High-resolution 23-Na (top), natural abundance 17-O (middle) and natural abundance 17-O with constrained reconstruction (bottom) images of human brain collected at 9.4 T.

**CONCLUSION**

Human 17-O imaging can be achieved at 9.4 T and enhanced by constrained reconstruction.

**REFERENCES**


Acknowledgements: The authors acknowledge financial support from the University of Illinois for the 9.4 Tesla scanner.

**KEY WORDS:** Oxygen, ultra-high field

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**Paper 383 Starting at 10:54 AM, Ending at 11:02 AM**

**Initial Experience in Cerebral and Spinal MR Imaging Studies for Patients with Permanent Cardiac Pacemakers**

Goldsher, D.; Shreiber, R.; Eran, A.; Daitzchman, M.; Roguin, A.

1Rambam Medical Center, Haifa, ISRAEL, 2Technion, Israel Institute of Technology, Haifa, ISRAEL, 3Johns Hopkins Medical Institution, Baltimore, MD

**PURPOSE**

To report our initial experience in performing cerebral and spinal MRI studies for patients with neurologic disorders and permanent cardiac pacemakers.

**MATERIALS & METHODS**

Thirteen patients with clinical indications for cerebral and spinal MRI and implanted pacemaker as the only contraindication were enrolled in this prospective study. Informed consent was obtained. They all had implanted pacemakers shown to be safe by in vitro and in vivo animal testing. In each patient the pacemaker was programmed to pacing-off. Continuous electrocardiographic telemetry, breathing rate, pulse oximetry and symptoms were monitored during the study. Specific absorption rate was limited to 4.0 W/kg for all sequences. Device parameters were assessed before, immediately after MRI, and 1-3 weeks later. Minimal average and maximal SAR values were taken.

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RESULTS
Image quality was unremarkable for all 13 patients in all the sequences performed during the MRI studies and were not influenced by the pacemaker presence. Clinical relevant final diagnosis was achieved in all cases. During the study, no device movement was felt by the patients and no episodes of inappropriate inhibition or rapid activation of pacing were recorded. At device interrogation there were no significant differences in device parameters pre, post, and at follow up.

CONCLUSION
Given appropriate precautions, MRI can be performed safely in patients with neurologic disorders and permanent cardiac pacemakers. In view of the advancing population age and the expanding indications for pacing along with the growing needs for brain imaging in old age, this may have significant implications for current MRI contraindications.

KEY WORDS: Adult brain

Paper 384 Starting at 11:02 AM, Ending at 11:10 AM
32-Channel Head Array Coil for MR Systems at 3.0 T: First Clinical Data
Petropoulos, L. · Holwell, J. · Jones, M. · Watson, M. · Bradshaw, K.
MR Instruments
Minneapolis, MN

PURPOSE
The quest for massive multichannel array systems in MR imaging usually is driven by three important factors: 1) increase in signal to noise ratio (SNR), 2) increase in coverage and 3) reduction of the imaging time. Over the past couple of years MRI systems have been equipped with the capability of accepting multichannel RF coils. Incorporating parallel imaging techniques like SENSE and GRAPPA with multichannel arrays can provide competitive advantage in reduction of scan times and improve image resolution. Pairing the multichannel coils with a 3.0 T MRI system creates a formidable diagnostic tool. In the present paper, the clinical data of a 32-channel head RF coil for a 3.0 T MRI scanner is presented. Taking advantage of the coil’s superior SNR, astonishing image uniformity over the entire head, it was feasible to obtain high-resolution 3D MRA images without gadolinium uptake with SENSE factors of six or higher and collecting the entire data is less than 17 seconds.

MATERIALS & METHODS
This coil had as an objective to maintain at least an internal diameter of 25 cm and a length of 24 cm. The image uniformity of 90% or better over the entire head including the occipital lobe was imperative. Demands for an increase of 40% in SNR at the center of the brain and more than 140% at the periphery of the head over commercially available 8-channel coils also was a requirement. These goals were realized by a structure that contained 32 loop elements. Each of these elements was geometrically decoupled from the adjacent element with an isolation of -20dB. Low input impedance preamps also were implemented in order to increase the isolation between adjacent elements.

RESULTS
Utilizing a GE 3.9 T HDx MRI scanner, phantom data was obtained and compared with the 8-channel brain coil. A SE sequence with Te=15ms, TR=500ms, Matrix=256x256, FOV =22cm and slice thickness=3mm was utilized. The 32-channel head coil demonstrated a 40% increase in SNR at the center of phantom and more that 150% increase in SNR at the periphery. The 32-channel demonstrated a 90% plus image uniformity along 15cm of the longitudinal (z) axis.

CONCLUSION
In comparison, the 8-channel demonstrated a 90% plus image uniformity for only z-3cm along the longitudinal axis. As a representative, Figure demonstrates a 3D CE MRA 200x200, 0.6mm thick - Asset factor 6 (interpolated to pixres. 0.35x0.32x0.30) with overall imaging time of 17 seconds.

KEY WORDS: RF, coil, image data

Paper 385 Starting at 11:10 AM, Ending at 11:18 AM
Postcontrast T1 Imaging of the Brain at 3 T: 2D Gradient Echo vs 2D Conventional Spin-Echo: A Prospective Study in 200 Patients
Shapiro, M. D.1 · Stanzione, J.2
1Neuroskeletal Imaging Winter Park, Winter Park, FL, 2University of Miami, Miami, FL

PURPOSE
The purpose of this study was to determine which of two pulse sequences, 2D T1-weighted gradient-echo (GRE) pulse sequence or T1-weighted conventional spin-echo (CSE) is better for detecting pathologic enhancement of the brain at 3 T with half dose (.05mmole/kilogram) of gadolinium DTPA.

MATERIALS & METHODS
In 200 consecutive patients who were scanned for a broad spectrum of neurologic clinical symptoms, MRI scans of the brain were performed on a GE 3T HDX system with the appropriate standard protocol plus one additional postcontrast T1 axial pulse sequence. In the first 100 patients the post T1 CSE (3mm slice thickness, 320x 256 matrices,TR=633msec, TE=10msec,2Nex TA +2:31) pulse sequence was obtained immediately prior to the T1 GRE( 3mm, 320x256matrices, TR=200msec, TE=2msec, FA+60 degrees) sequence. In patients 101-200, the T1GRE was obtained as the first postgadolinium axial pulse sequence. All scans were reviewed by two radiologists for number and
RESULTS

There were 98 pathologic enhancing lesions. All 98 were identified on the T1 CSE pulse sequence. Ninety-seven were identified on the T1 GRE. Most lesions were more conspicuous on the second postcontrast sequence. Eight lesions were more conspicuous on the CSE sequence obtained first.

CONCLUSION

Both T1 GRE and T1 CSE will identify most pathologic-enhancing lesions of the brain at 3 T. T1 CSE is a longer but slightly more sensitive pulse sequence. Most lesions are more conspicuous on the second, more delayed, pulse sequence.

KEY WORDS: MRI, brain, gadolinium

Paper 386 Starting at 11:18 AM, Ending at 11:26 AM

Global and Regional Brain Aging Patterns over the Human Life Span with T2 Histogram Analysis

Saito, N. · Jara, H. · Sakai, O.
Boston Medical Center/Boston University School of Medicine
Boston, MA

PURPOSE

To study the age dependence of T2 histograms of the brain as divided in six subsegments (bilaterally anterior cerebrum, posterior cerebrum and cerebellum segments) and over the full human life span using the mixed-TSE pulse sequence and dual-clustering segmentation.

MATERIALS & METHODS

Seventy-seven subjects (47 males, 30 females, age range 0.5-87 years) were enrolled for this study: 29 volunteers and 48 patients who were referred to MRI for various clinical reasons. All subjects were imaged with the mixed-TSE pulse sequence with a 1.5 T MR scanner (Philips Medical Systems, Cleveland, OH). The brain was segmented from the whole head data set using a dual-clustering segmentation algorithm. We further divided the whole brain segment into six subsegments: right and left anterior cerebrum, posterior cerebrum and cerebellum segments. Segmentation and T2 Q-MRI algorithms were programmed by MathCAD 2001i (Mathsoft, Cambridge, MA). T2 relaxation time histograms of all segments were generated with a pixel counting algorithm and further modeled with Gaussian functions. Peak values were derived from the histograms and plotted as functional of age.

RESULTS

Figure 1 shows a graph of the peak T2 relaxation times vs age: shown are data for the right cerebrum and cerebellum. Almost identical graph (not shown) is generated with the left brain subsegments. T2 relaxometric changes were most pronounced in the first 10 years of life. T2 decreased rapidly in the first 2 years and continued to decrease gradually by 20 years of age. In the 21 to 55 range, the T2 distributions were approximately constant. For seniors, 56 years and older, T2 increased very gradually. T2 histograms had very similar tendencies for the six studied subsegments; however, small regional differences were observed, specifically longer T2 values for the anterior compared to posterior subsegments during the first 5 years of life.

CONCLUSION

T2 relaxation times of six subsegments were measured for 77 subjects and the age dependence of T2 histograms was demonstrated. As found by others (1), most pronounced T2 relaxometric changes occur very early in life, consistent with rapid myelination. These results could be useful for establishing T2 relaxometry standards for all ages.

REFERENCES


KEY WORDS: Brain aging, quantitative MRI, T2 relaxation time

Paper 387 Starting at 11:26 AM, Ending at 11:34 AM

Secular-T2 Relaxometric Brain Aging Patterns over the Human Lifespan

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Boston Medical Center/Boston University School of Medicine
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PURPOSE

T1 and T2 information are not fully independent of each other because all spin-lattice interactions that cause T1 recovery also contribute to T2 decay. The difference between the T1 and T2 relaxation rates represents the pure spin-spin interactions and is known as the secular relaxation rate. The associated secular-T2 relaxation time is given by T2$^{sec} = T2 / (1 - T2/2T1)$. The purpose of this study is to examine the age dependence of secular-T2 histograms of the brain divided in six subsegments (bilaterally anterior cerebrum, posterior cerebrum and cerebellum segments) over the full human lifespan using the mixed-TSE pulse sequence and dual-clustering segmentation.
Seventy-seven subjects (47 males, 30 females, age range 0.5-87 years) were enrolled for this study, which is a continuation of prior work (1): 29 volunteers and 48 patients who were referred to MRI for various clinical reasons. All subjects were imaged with the mixed-TSE pulse sequence with a 1.5 T MR scanner (Philips Medical Systems, Cleveland, OH). The brain was segmented from the whole head data set using a dual-clustering segmentation algorithm. We further divided the whole brain segment into 6 subsegments: right and left anterior cerebrum, posterior cerebrum and cerebellum segments. All segmentation algorithms were programmed by MathCAD 2001i (Mathsoft, Cambridge, MA). T2 and secular-T2 relaxation time histograms of all segments were generated and further modeled with Gaussian functions. Peak values were derived from the histograms and plotted as functional of age.

RESULTS
Figure 1 shows a graph of the peak T2 and secular-T2 relaxation times vs age: shown are data for the right cerebrum and cerebellum. Relaxation times of secular-T2 were longer than that of T2 by about 10% for all ages, although they had a very similar relaxation pattern.

CONCLUSION
Secular-T2 relaxation times of all six subsegments were measured for each 77 subjects and the age dependence of secular-T2 histograms was demonstrated. Secular-T2 and T2 histograms (2) are very similar functionally, thus suggesting that T1 processes do not significantly influence the observed T2 brain aging pattern.

REFERENCES

KEY WORDS: Brain aging, quantitative MRI, secular-T2 relaxation time

TEMPRAL CHANGES IN CEREBRAL PERfusion ASSOCIATED WITH POSTERIOR REVERSIBLE ENCEPHALOPATHY SYNDROME AS MEASURED WITH MR ARTERIAL SPIN LABELING

Whitlow, C. T. · Pollock, J. M. · Kraft, R. A. · Mussat-Whitlow, B. J. · Tan, H. · Burdette, J. H. · Maldjian, J. A.
1Wake Forest University School of Medicine, Winston-Salem, NC, 2Winston-Salem State University, Winston-Salem, NC

PURPOSE
Posterior reversible encephalopathy syndrome (PRES) has been associated with both increases and decreases in cerebral blood flow (CBF), depending upon the study cited. We hypothesize that these seemingly discordant findings may reflect a continuum of temporal changes in CBF related to disease evolution. The purpose of this study, therefore, was to evaluate possible time-associated changes in gray-matter (GM) perfusion in patients with PRES, using arterial spin labeling (ASL).

MATERIALS & METHODS
Six subjects demonstrating T2/FLAIR signal increases in parietooccipital white matter were identified retrospectively from a pool of over 3000 MRI examinations with ASL perfusion imaging performed over 1 year, and divided into acute and subacute groups based upon latency between symptom onset and imaging. Age-matched control subjects (n=12) with no abnormalities on conventional MR sequences were selected randomly. Gray-matter perfusion (mL/100g/minute) was quantified in all subjects for two regions of interest: parietooccipital and frontal cortex. A 3 (group: control, acute PRES, subacute PRES) x 2 (cortical region: parietooccipital, frontal) ANCOVA was conducted using GM perfusion as the dependent measure and subject age as a covariate. Bonferroni adjusted posthoc analyses subsequently were conducted to evaluate between-group effects.

RESULTS
Acute PRES subjects (n=2) were 23 and 66 years of age, and imaged less than 24 and 48 hours after onset of symptoms, respectively. Subacute PRES subjects (n=4) were 37, 32, 49, and 49 years of age, and imaged 7, 6, 15, and 38 days after onset of symptoms, respectively. Subacute PRES subjects (n=4) were 37, 32, 49, and 49 years of age, and imaged 7, 6, 15, and 38 days after onset of symptoms, respectively. ANCOVA revealed a significant interaction of group by region [F(2,137)=3.28, p=0.041], such that rates of CBF in GM were slightly higher in parietooccipital as compared to frontal cortex for acute PRES subjects, but slightly lower in parietooccipital as compared to frontal cortex for acute PRES subjects, but slightly lower in parietooccipital as compared to frontal cortex for acute PRES subjects. There was a main-effect of group [F(2,137)=132.55, p<0.001], such that rates of CBF in GM were slightly higher in parietooccipital as compared to frontal cortex for acute PRES subjects, but slightly lower in parietooccipital as compared to frontal cortex for acute PRES subjects, and lower in subacute PRES subjects, as compared to controls. Specifically, Bonferroni adjusted posthoc analyses revealed rates of CBF to be significantly higher in parietooccipital (acute PRES: 133.7±20.7, Controls: 72.9±17.1) (p<0.001) and frontal (acute PRES: 115.3±11.2, Controls: 72.9±18.1) (p<0.001) cortex of the acute PRES group, and significantly lower in parietooccipital (subacute PRES: 46.5±15.3, Controls: 72.9±17.1) (p<0.001) and frontal (subacute PRES: 52.0±18.0, Controls: 72.9±18.1) (p<0.001) cortex of the subacute PRES group, as compared to controls.

KEY WORDS: Cerebral perfusion, posterior reversible encephalopathy syndrome, arterial spin labeling

PAPER 388 STARTING AT 11:34 AM, ENDING AT 11:42 AM

AGE-RELATED CHANGES IN CEREBRAL BLOOD FLOW USING ASL IN PATIENTS WITH POSTERIOR REVERSIBLE ENCEPHALOPATHY SYNDROME (PRES)

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PURPOSE
To determine age-related changes in cerebral blood flow (CBF) in patients with posterior reversible encephalopathy syndrome (PRES), using arterial spin labeling (ASL).

MATERIALS & METHODS
We acquired ASL images of 20 patients with PRES and 20 normal controls (10 males, 10 females, age range 24-87 years). CBF was measured in the parietooccipital cortex, divided into subacute (n=9) and acute (n=11) groups. Mixed-T2* imaging was performed on a 3 T MR scanner (Philips Achieva, Netherlands) using the single-shot ASL technique (TR/TE=1500/50 ms; 4x4x4 mm). The ASL images were analyzed using the hybrid registration method (MRArt) and combined with FLAIR images to identify abnormal regions. CBF was calculated as the ratio of arterial blood flow to blood volume, and compared using a paired t-test. As clinical features may influence CBF, subject age was used as a covariate.

RESULTS
We found significant age-related changes in CBF in the parietooccipital cortex, with a decreasing trend in acute PRES (p<0.001) and an increasing trend in subacute PRES (p=0.041). The trend was significant after adjusting for subject age (p<0.001). In controls, CBF remained constant with age.

CONCLUSION
Age-related changes in CBF were observed in patients with PRES, with a decrease in acute PRES and an increase in subacute PRES. These changes may reflect disease progression and evolution.

KEY WORDS: Cerebral blood flow, posterior reversible encephalopathy syndrome, arterial spin labeling

Friday
Cerebral blood flow was demonstrated to be elevated in patients with PRES when imaged acutely following symptom onset, and diminished when imaged at more subacute time-points. As such, seemingly discordant findings of PRES-associated increases and decreases in CBF across different studies may be related to temporal changes in cerebral perfusion associated with disease evolution. Although no signal abnormalities were detected in frontal cortex of PRES subjects using conventional MR sequences, there were statistically significant changes in ASL measures of frontal GM perfusion. It is possible that posterior changes classically ascribed to PRES are manifestations of a continuum of more widely distributed perfusion abnormalities affecting cortical GM, which may underlie different topographic patterns of PRES that have been reported recently.

**Key Words:** Posterior reversible encephalopathy syndrome, MR arterial spin labeling, cerebral blood flow

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**Paper 389 Starting at 11:42 AM, Ending at 11:50 AM**

**Is All Communicating Hydrocephalus Really Communicating? Value of 3D Constructive Interference in Steady State Sequence in the Classification of Hydrocephalus at 3 T**

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Istanbul, TURKEY

**Purpose**
Three-dimensional fourier transformation constructive interference in steady state (CISS) sequence has gained acceptance in the management of hydrocephalus. The purpose of the study was to evaluate the additive value of high resolution isometric voxel CISS in the classification of hydrocephalus as either obstructive or communicating at 3 T.

**Materials & Methods**
One hundred three patients with hydrocephalus were examined at a 3 T system with axial TSE T2, SE T1, coronal TSE T2, sagittal TSE T2, sagittal midline and axial oblique cinePC perpendicular to aqueduct of Sylvis, and sagittal 3D CISS (0.6x0.6x0.6 mm3 isometric voxel). High-resolution 3D CISS acquisition was supplemented by axial, coronal, and/or oblique reformations (multiplanar reconstruction method).

**Results**
The 3D CISS MRI allowed precise visualization of obstructive cisternal membranes in 39 patients (membranous obstruction of the foramen of Monro in five patients, bilateral membranous obstruction of the foramen of Luschka in 21 patients, membranous obstruction of both foramen of Luschka and Magendie in six patients, membranous obstruction of the foramen of Magendie in four patient, membranous obstruction of the fourth ventricle inlet below the aqueduct of Sylvis in three patients). Conventional sequences suggested the diagnosis of obstructive hydrocephalus only in seven patients, revealing either the indirect sign of obstruction of the foramen Monro in five patients or demonstrating the membranes of the fourth ventricle inlet and foramen of Luschka in two patients. There was dual pathology in 11 patients (aqueductal stenosis in seven patients and arachnoid cyst in four patients) which was visible in conventional sequences, already suggesting the diagnosis of obstructive hydrocephalus. In the other 21 patients, classical sequences suggested the diagnosis of communicating hydrocephalus which was indeed incorrect. As a result, the conventional sequences classified the patients as communicating hydrocephalus in 54 patients and obstructive hydrocephalus in 49 patients. But, CISS sequences altered the diagnosis from communicating to obstructive hydrocephalus in 21 out of 54 patients (39%).

**Conclusion**
Implementation of 3D CISS in conjunction with the classical sequences for evaluation of hydrocephalus not only supports invaluable anatomical information, but also demonstrate the fine obstructive membranes which otherwise can be invisible and may alter the diagnosis which affects the decision-making process in the treatment of hydrocephalus.

**Key Words:** Hydrocephalus, CISS

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**Paper 390 Starting at 11:50 AM, Ending at 11:58 AM**

**Imaging Appearances of the Central Nervous System in Patients with Gluten Sensitivity and Neurologic Symptoms Responsive to a Gluten-Free Diet**

Batty, R. • Hadjivassiliou, M. • Wilkinson, I. D. • Griffiths, P. D. • Connolly, D. J. • Romanowski, C. A. J. • Hodgson, T. J. • Coley, S. C. • Hoggard, N.
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**Purpose**
There is increasing support for an association between gluten sensitivity and a wide range of neurologic symptoms that respond to instigation of a gluten-free diet. We describe the correlation between neurologic symptoms and imaging findings in a group of patients with gluten sensitivity responsive to a gluten-free diet and the effects of this diet on interval scans.

**Materials & Methods**
Sixty-six patients form Sheffield’s gluten sensitivity neurology clinic met the selection criteria, including positive antigliadin antibodies, genetic predisposition to gluten sensitivity (HLA DQ2, DQ8, DQ1) and neurologic symptoms and signs showing improvement or stabilization on a gluten-free diet. Fifty-four of those 66 patients had undergone multiplanar 1.5 T MR imaging of the brain including at least axial and coronal dual echo and sagittal T1-weighted sequences. Imaging was reviewed independently by two experienced neuroradiologists. The number, extent and location of any periventricular, deep and peripheral white matter; basal ganglia, thalamic, corpus callosum, brainstem and cerebellum signal abnormalities were recorded. The presence and distribution of any cerebellar atrophy was graded. Spinal imaging was reviewed when available (25/54) for cord atrophy and signal change.

**Results**
The mean age was 57 years and 34/54 patients were female.
Twenty-five of 54 had biopsy proved gluten sensitive enteropathy. All 54 patients had some demonstrable abnormality on brain imaging. Five distinct patterns of imaging abnormality emerged. Twenty-three of 54 patients had a “vascular” pattern of white matter hyperintensities; clinically, 18 of these 23 had gluten encephalopathy (episodic severe unilateral headache +/- focal neurologic deficit); 4/34 had gluten ataxia and 1/43 had symptoms attributable to the spinal cord. Seven of 54 patients showed a “demyelination” imaging pattern; clinically four of these seven had symptoms similar to primary progressive multiple sclerosis; 2/7 had symptoms attributable to the spinal cord and 1/7 had gluten encephalopathy. Eleven of 54 showed cerebellar atrophy all of which had gluten ataxia clinically. Twelve of 54 had a combination of cerebellar atrophy and a “vascular” pattern of white matter hyperintensities; clinically 6/12 had gluten encephalopathy and 6/12 had gluten ataxia. One of 54 had occipital calcification and epilepsy. Twenty-five of 54 patients had interval scans (mean time between scans of 71 months). Four of 25 showed no, 11/25 showed mild, 6/25 showed moderate, 4/25 showed severe interval change.

**CONCLUSION**

All 54 patients had some abnormality on brain MR imaging. Five distinct imaging groups could be identified, which, with a few exceptions correlated well with clinical symptoms. A spectrum of neurologic symptoms and imaging findings were seen in a group of patients united by their immunologic findings and symptom response to a gluten-free diet. Imaging abnormalities remained static or progressed slowly with time.

**KEY WORDS:** Gluten sensitivity, MRI, ataxia

**Paper 391 Starting at 11:58 AM, Ending at 12:06 PM**

**Neuroimaging of Cerebral and Facial Involvement in Erdheim-Chester Disease**

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**PURPOSE**

To study and describe the MR features of intracranial, orbital and facial bones lesions in Erdheim-Chester disease.

**MATERIALS & METHODS**

We retrospectively reviewed the cerebral MR images of 25 histologically proved cases of Erdheim-Chester disease with intracranial, facial bones and/or orbital lesions on MRI. The locations (meninges, brain, pituitary stalk, orbits, facial bones and sinuses), size and number of lesions, and gadolinium enhancement were analyzed.

**RESULTS**

Intracranial lesions were present in 11/25 patients (44%): 7/11 (63%) had meningeal involvement with a single (n=2) or multiple (n=3) focal mass lesions mimicking meningioma, or diffuse dural thickening (n=2). Three of 11 (27%) presented with an isolated intraaxial lesion, and only 1/11 patients (9%) demonstrated both meningeal and intraaxial involvement. Among those patients with intracranial lesions, 4/11 (36%) also had hypothalamic and pituitary stalk lesions. Facial bone involvement was observed in 22/25 patients (88%) and bilateral lesions of maxillary sinuses were the most frequent pattern (n=9/25, 36%). Orbital involvement was present in 7/25 patients (28%), with four cases of bilateral intracanal nodular lesions. All patients with an orbital lesion also harbored intracranial and sinuses involvement.

**CONCLUSION**

This study demonstrates the frequent association between intracranial masses (meningeal and intraxial), orbital lesions and maxillary sinuses involvement in Erdheim-Chester disease.

**KEY WORDS:** Erdheim-Chester, neurologic, facial

**Paper 392 Starting at 12:06 PM, Ending at 12:11 PM**

**Rosai-Dorfman Disease Involving Central Nervous System: Report of Two Cases**

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**PURPOSE**

To discuss the role of imaging of Rosai-Dorfman disease (RDD) involving the central nervous system (CNS) based on literature review.

**CASE REPORT**

Case 1: A 33-year-old African-American female presented with 5-year history of headaches and recent onset of double vision, hearing loss and motor weakness. MR imaging showed a dural-based lesion centered over the left petroclival region. Partial excision was performed with stability of the lesion at 15 months follow-up. Case 2: An eighteen-year-old Hispanic male, with a known diagnosis of Rosai-Dorfman disease, presented to the Miami Children’s Hospital with cervical myelopathy. Patient had multiple allergies, and atopic dermatitis. MR imaging showed multiple dural-based nodular lesions in the brain and cervical spine. Lesions regressed significantly in size over 30 months with chemotherapy.

**IMAGING FINDINGS**

Case 1: MR imaging of the brain demonstrated a dural-based left petroclival and prepontine mass with extension to the left parasellar region with mass effect on the pons, basilar and vertebral arteries. Lesion was isointense on T1-weighted images (T1WI) and hypointense on T2-weighted images (T2WI) with homogenous postcontrast enhancement. Hemorrhagic infarct was seen in the left side of the pons which later resolved. Case 2: MR imaging of the brain and whole spine showed multiple lobulated dural-based masses along the clivus, posterior fossa cistern, Meckel’s cave and cavernous sinus, suprasellar region, planum sphenoidale, right frontal convexity, cervico-medullary junction and cervical spinal canal at C1 and C2 level with signal characteristics similar to that in case 1. Cord expansion with signal abnormality was seen at C4 level. Both the cases were identified as RDD based on histologic and immunohistochemical findings.
SUMMARY
Also known as sinus histiocytosis with massive lymphadenopathy (SHML), RDD is a benign histiocytic proliferative disorder with characteristic histologic findings. Forty-three percent cases show extranodal involvement including skin, upper respiratory tract, bones and orbit. So far, approximately 84 cases of CNS involvement have been reported, and 50% of them are exclusively in the CNS. Ratio of cranial to spinal involvement is 4:1. Over 60 articles on isolated CNS-RDD are reported and very few have imaging findings. Majority of the lesions described are dural-based with propensity to arise from skull base, suprasellar region, cavernous sinus, posterior fossa cisterns and convexities. Size varies from mild dural thickening to giant, lobulated lesions causing extensive mass effect. Isolated reports of intraparenchymal location in the brain as well as spinal cord have also been noted. Lesions are characteristically isointense on T1WI and hypointense on T2WI with homogeneous postcontrast enhancement. They are mostly hypovascular on angiography, and if hypervascular, they tend to derive blood supply from intracranial circulation as opposed to meningioma where extracranial supply is seen. Although RDD is a histologic diagnosis, the radiologist may be the first to suggest the lesion. Hence, RDD should be recognized by neuroradiologists as a rare differential diagnosis of dural-based lesions.

KEY WORDS: Rosai-Dorfman disease, central nervous system, sinus histiocytosis with massive lymphadenopathy

Paper 393 Starting at 12:11 PM, Ending at 12:16 PM
Duplicated Pituitary Gland and Persistent Trigeminal Artery in a 74-Year-Old Female: How the Embryonic Development of Both Are Interrelated
Javeri, K. K. · Corrigan, J. · Schooley, B.
Henry Ford Health System
Detroit, MI

PURPOSE
The purpose of this scientific exhibit will be to incorporate the embryonic development of the duplicated pituitary gland along with that of the persistent trigeminal artery.

CASE REPORT
The methods used were computed tomography and contrast-enhanced MR imaging. Findings in a 74-year-old female patient include a duplicate pituitary gland along with an intrasellar persistent trigeminal artery. Findings also include a duplicate basilar arterial system, fusion anomalies of the cervical spine and Chiari I malformation. This patient is the oldest documented patient with a duplicate pituitary and does not have the endocrine abnormalities, hypertelorism, and anosmia usually associated with duplicated pituitary gland. Patients with duplicated pituitary gland typically do not survive beyond infancy.

IMAGING FINDINGS
The contrast-enhanced CT image shows a duplicated pituitary gland with a pneumatized septum in the sphenoid sinus between the two glands. The coronal MR image shows the dual pituitary gland stalks with a left-sided intrasellar flow-void corresponding to the persistent trigeminal artery. The discussion will include an analysis of the embryonic development of the pituitary gland and will incorporate it with the development and usual regression of the trigeminal artery.

SUMMARY
The conclusion of this exhibit will be to examine whether the presence of a persistent trigeminal artery helps establish timing of the insult resulting in the duplicated pituitary gland and its associated anomalies.

KEY WORDS: Duplicate pituitary, patent trigeminal artery, Chiari I
Paper 394 Starting at 10:30 AM, Ending at 10:38 AM

Contrast-Enhanced MR Imaging of Cerebral Gliomas and Metastases

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1University of Wisconsin, Madison, WI, 2Southern Illinois University, Springfield, IL, 3Hospital Sant Pau, Barcelona, SPAIN, 4University of Pavia, Pavia, ITALY, 5Catholic University of the Sacred Heart, Rome, ITALY

PURPOSE
To qualitatively and quantitatively evaluate equivalent doses of the high-relaxivity contrast agent gadobenate dimeglumine (Gd-BOPTA; MultiHance) compared to the conventional agent gadodiamide (Gd-DTPA-BMA; Omniscan) for contrast-enhanced magnetic resonance imaging (MRI) in patients with cerebral glioma or metastases.

MATERIALS & METHODS
Patients with primary glial tumors (n=47) or brain metastases (n=27) underwent two identical MR examinations (1.5 T) separated by 3-14 days, one with 0.1 mmol/kg bodyweight Gd-BOPTA and the other with the same dose of Gd-DTPA-BMA. Imaging sequences and postinjection acquisition timing were identical for the two exams (T1wSE and T1wGRE sequences at 3-7 min postdose). Three independent, blinded neuroradiologists evaluated matched pairs of images qualitatively (global diagnostic preference, lesion border delineation, definition of extent of disease, visualization of lesion internal morphology, and lesion contrast enhancement) and quantitatively (percent enhancement and contrast-to-noise ratio (CNR)). Wilcoxon signed rank test was used to determine differences between the agents and kappa (κ) statistics were used to measure interreader agreement.

RESULTS
For both gliomas and metastases, expert readers demonstrated a highly significant preference for Gd-BOPTA for all diagnostic information endpoints (Table). Three-reader agreement for the qualitative evaluation of lesions was good, with κ values ranging from 0.43-0.57 for gliomas and 0.56-0.63 for metastatic lesions. Quantitative enhancement was performed for: 25, 35, and 30 gliomas and 29, 26, and 26 metastases on T1w SE images; and for 22, 32, and 26 gliomas and 27, 25, and 23 metastases on T1w GRE images (readers 1, 2, and 3, respectively). Highly significant increases in quantitative enhancement with Gd-BOPTA relative to Gd-DTPA-BMA were noted by each reader for both percent of lesion enhancement and CNR for each lesion type. On postdose SE images, the percent increase in CNR with Gd-BOPTA ranged from 19-34% for gliomas and 24-36% for metastases, while on postdose GRE images, the percent increase in CNR with Gd-BOPTA ranged from 25-44% for gliomas and 33-61% for metastases. Although the absolute CNR values were higher on T1wSE acquisitions, the magnitude of CNR increases with Gd-BOPTA was greater for signal intensity measurements made on T1w GRE acquisitions.

CONCLUSION
In a direct comparison of equivalent doses (0.1 mmol/kg bodyweight) of Gd-BOPTA and Gd-DTPA-BMA, three blinded neuroradiologists overwhelmingly preferred images generated with Gd-BOPTA, both qualitatively and quantitatively, for enhanced MR imaging of patients with gliomas and metastases.

KEY WORDS: CNS lesions, MRI, contrast media

Paper 395 Starting at 10:38 AM, Ending at 10:46 AM

Clinical Assessment of Standard and GRAPPA Parallel Diffusion Imaging: Effect of Reduction Factor and Matrix Size

Zaharchuk, G. · Augustin, M. · Fischbein, N. J. · Skare, S. · Rosenberg, J. · Newbould, R. D. · Lansberg, M. G. · Kemp, S. · Wijmann, C. · Moseley, M. E. · Albers, G. W. · Bammer, R.

1Stanford University, Stanford, CA, 2University of Graz, Graz, AUSTRIA

PURPOSE
Parallel imaging offers particular advantages for diffusion-weighted imaging (DWI), such as reduction of susceptibility artifacts, increased spatial resolution, reduced eddy current distortions, and increased SNR due to echo time reductions. This study examined the effects of higher in-plane spatial resolution (192 vs 128 square) and reduction factor (R=1 and R=3) upon subjective assessment of image quality metrics.
Materials & Methods

The study was approved by the local IRB and was HIPAA compliant. In 28 patients (8 acute ischemic stroke, 10 intraparenchymal/intraventricular hemorrhage, 4 both acute ischemic stroke and hemorrhage, and 5 negative), four separate diffusion-weighted sequences were acquired during the same imaging session on a 1.5 T GE scanner: (1) 128x128 matrix, R=1, TE=70ms; (2) 192x192 matrix, R=1, TE=83-90ms; (3) 128x128 matrix, R=3, TE=57ms; (4) 192x192 matrix, R=3, TE=60ms. Scan time for standard unaccelerated scans was 48 seconds and for R=3 parallel images was 2 min. Shared parameters for all scans included 5 mm slice thickness with 1.5 mm gap, b=1000s/mm^2 (3 directions), FOV 24 cm. The studies were presented blinded and in random order to 3 neuroradiologists who rated the studies for overall image quality, susceptibility artifact, motion artifact, spatial resolution, subjective noise assessment, and lesion conspicuity (scale 1-5, much worse to much better, with 3 representing the same as compared to a “typical DWI scan”). A mixed-effects logistic regression with fixed factors of matrix size (128 or 192) and reduction factor (R=1 or R=3) was performed assuming random effects of patient and reader.

Results

Table shows the odds ratios for reviewers stating that the images were better (rated 4 or 5) rather than the same or worse (1 to 3). Increased reduction factor had the greatest positive effect, particularly upon overall quality (O.R. 19.9±6.6, p<0.001) and susceptibility artifact (29.6±12.4, p<0.001). Increased matrix size also had a smaller but still significant improvement, particularly for overall quality and lesion conspicuity. Of the imaging conditions studied, we believe R=3 accelerated 192x192 matrix scans were best suited for clinical DWI at 1.5 T.

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<tr>
<th>Metric</th>
<th>Matrix Reduction Factor Significance</th>
<th>Overall Quality 6.6±2.1 p&lt;0.001</th>
<th>Susceptibility Artifact 1.5±0.5 p&lt;0.001</th>
<th>Motion Artifact 1.0±0.5 p&lt;0.001</th>
<th>Spatial Resolution 5.1±1.3 p&lt;0.001</th>
<th>Noise Level 2.7±0.9 p&lt;0.001</th>
<th>Lesion Conspicuity 5.7±2.0 p&lt;0.001</th>
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<tr>
<td>Matrix Reduction Factor</td>
<td>(R=3 vs. R=1)</td>
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<tr>
<td>Overall Quality</td>
<td>19.9±6.6 p&lt;0.001</td>
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<td>Susceptibility Artifact</td>
<td>29.6±12.4 p&lt;0.001</td>
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<td>Motion Artifact</td>
<td>4.0±2.1 p&lt;0.001</td>
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<tr>
<td>Spatial Resolution</td>
<td>4.7±1.2 p&lt;0.001</td>
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<td>Noise Level</td>
<td>4.1±1.5 p&lt;0.001</td>
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<td>Lesion Conspicuity</td>
<td>4.3±1.5 p&lt;0.001</td>
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Conclusion

Readers found that accelerated scans (R=3) led to significant improvement in all metrics measured, but which was most pronounced on overall image quality and reduced susceptibility artifact, without adverse effects on lesion conspicuity or motion artifact. Increasing matrix size to 192x192 also led to smaller but still significant improvement, particularly for overall quality and lesion conspicuity. Of the imaging conditions studied, we believe R=3 accelerated 192x192 matrix scans were best suited for clinical DWI at 1.5 T.

Key Words: Diffusion, parallel imaging, MRI
CONCLUSION
The PRESTO sequence combined with PI provides SW images of good quality with minimal postprocessing in a short scanning time.

KEY WORDS: Susceptibility, PRESTO, parallel imaging

Paper 397 Starting at 10:54 AM, Ending at 11:02 AM
Optimal Image Transformation for Thresholding: An Initial Step for Autosegmentation for Brain Tumor Volumetry

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PURPOSE
To identify an optimal image transformation that separates tumor from normal brain in one dimension, permitting segmentation for volumetry using simple thresholding and incorporation of such transformed images into multidimensional segmentation.

MATERIALS & METHODS
Using images from subjects with malignant gliomas, we studied unidimensional separation of tumor from nonneoplastic brain on FLAIR, precontrast T1-weighted, postcontrast T1-weighted, and apparent diffusion coefficient maps. The transformations applied were raising the images to a power of two or a power of four, and exponentiation. The native images and the transformed images then were used as inputs for multidimensional segmentation combining two or more base images. We constructed histograms of signal intensity on each image in the region of abnormality and compared these to histograms of normal brain. Expert opinion was used as the gold standard for tissue classification. We evaluated each unidimensional and multidimensional segmentation based on ability to distinguish the tumor feature of interest from normal brain, both on histogram criteria and against expert reviewer.

RESULTS
Native images displayed substantial overlap between normal brain structures and brain tumor, as displayed on histograms, and with segmentations evaluated by an expert. Each image transformation applied improved upon the performance of the native images by both criteria. Unidimensional segmentations with these images demonstrated excellent separation of normal brain from apparent tumor, as compared to expert opinion, as well as by histograms. Multidimensional combinations did not improve on the unidimensional segmentations.

CONCLUSION
Although numerous sophisticated segmentation methods have been developed for tumor volumetry, complexity of implementation has limited their use for clinical purposes. Our goal was to identify simple approaches that produce reliable segmentations of brain tumors. Transforming the native images and performing segmentation on these appears to offer one such approach.

KEY WORDS: Volumetry, transformation, autosegmentation

Paper 398 Starting at 11:02 AM, Ending at 11:07 AM
Significant Potential Pitfall in FLAIR-PROPELLER Imaging

Farid, N. · Imbesi, S.
University of California San Diego
San Diego, CA

PURPOSE
Periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER), a relatively new technique in
magnetic resonance imaging (MRI), was developed to quantify and reduce head motion artifact and thereby improve image quality. Our case report demonstrates a significant artifact encountered on FLAIR-PROPELLER imaging in the setting of underlying intraparenchymal cerebral hemorrhage.

CASE REPORT
A 66-year-old male with history of amyloid angiopathy was admitted to the hospital for altered mental status and global aphasia. An MRI of the brain was performed.

IMAGING FINDINGS
The MRI demonstrates multiple foci of magnetic susceptibility artifact throughout both cerebral hemispheres on the gradient-echo images most prominent in the left parietal lobe and right temporal lobe, indicating chronic hemorrhagic products and consistent with the patient’s history of amyloid angiopathy. Of note, on the FLAIR-PROPELLER images, there is high signal intensity in several sulci within the area of magnetic susceptibility artifact in the left parietal lobe. However, on the standard FLAIR images, there is normal suppression of cerebrospinal fluid signal in these same sulci. In addition, these sulci are also normal on all other sequences as well as on the preceding head CT.

SUMMARY
In the setting of underlying intraparenchymal cerebral hemorrhage, there is failure of fluid signal attenuation on the FLAIR-PROPELLER sequence. As a result, high signal intensity is seen in the sulci within the area of intraparenchymal hemorrhage, which may be misinterpreted as subarachnoid hemorrhage or meningitis if one is unaware of this significant potential pitfall.

KEY WORDS: Propeller MRI, FLAIR, artifact

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**Measurements of Velocity, Wall Shear Stress and Pressure Differentials in Arteriovenous Malformations Using a Novel 7D Contrast-Enhanced MR Angiography Technique with an Acceleration Factor of 300**

Wu, Y. · Velikina, J. · Johnson, K. · Rowley, H. · Gentry, L. · Mistretta, C. · Turski, P. A.

University of Wisconsin
Madison, WI

**Purpose**
To generate highly accelerated 7D images (HYPR FLOW) that encompass the entire brain and display: 1) a temporal series with a reconstruction window of 0.75 seconds for each 3D volume, 2) maps of velocity, wall shear stress and pressure gradients.

**Materials & Methods**
We introduce a novel imaging method (HYPR FLOW) that dramatically accelerates contrast-enhanced time-resolved MRA and also encodes for velocity. The conventional Cartesian readout is replaced by an undersampled spherical readout and image data are processed using the recently developed highly constrained backprojection with local reconstruction (HYPR LR). Following contrast injection (2-3mL/s, 0.1 mm/kg) a time series of 3D whole brain images are obtained followed by 300 seconds of phase contrast velocity encoding. The acquisition uses an undersampled spherical readout (VIPR) that provides an acceleration factor of 300. The data are processed using (HYPR-LR) that takes advantage of the redundancy of information in a time series. The result is a series of images with high temporal, high spatial resolution and velocity encoding. HYPR FLOW exams were obtained in seven volunteer subjects and seven patients with brain AVMs. Parameters for the dynamic series were: TR/TE = 3.1/0.4 ms, temporal reconstruction window of 0.75 seconds. Parameters for the velocity encoding were: FOV = 20x20x20cm³, TR/TE = 12.5/4.8 ms, 300 sec. Total imaging time 350 seconds. Three-dimensional HYPR FLOW velocity data were used for the generation of 3D maps of shear stress, vector plots and pressures gradients using the Navier-Stokes equations.

**Results**
This is the first report of whole brain in vivo measurements of wall shear stress in AVMs. Our results indicate that wall shear stress is increased in the arteries that directly supply the AVM. Pressure is reduced in the major feeding arteries relative to normal contralateral arteries and flow volume is increased. Quantitative measure of the contrast kinetics demonstrated that HYPR LR processing maintained the true dynamic properties of the contrast bolus. Signal to noise for HYPR FLOW was preserved (51.2) even at a spatial resolution of 0.31mm³. Two frames from the HYPR FLOW demonstrate the arterial and venous components of the AVM - note the differential filling of the transverse sinuses (arrows).

**Conclusion**
We have shown that an acceleration factor of 300 can be achieved by radial undersampling (VIPR) and reconstruction using HYPR-LR. Furthermore, velocity encoding permits the derivation of clinically valuable maps of speed, pressure differentials, and shear stress.

**Key Words:** Acceleration, MRA, arteriovenous malformation
Lee, E.; Lee, S.; Agid, R.; Bae, J.; terBrugge, K.

1Toronto Western Hospital, Toronto, ON, CANADA, 2Kwandong University, Myong Ji Hospital, Goyang-Shi, REPUBLIC OF KOREA, 3Lahey Clinic Medical Center, Burlington, MA, 4Cheju National University, Cheju, REPUBLIC OF KOREA

**Purpose**

Before the introduction of combined automatic tube current modulation (ACTM) technique, craniocervical CTA had been using fixed current technique (300mA) in our institution. We evaluated the magnitude of radiation dose reduction of ACTM technique in 64-slice multidetector row craniocervical CT angiography (CTA).

**Materials & Methods**

Retrospective analysis of each consecutive 25 craniocervical CTAs before and after the adoption of ACTM technique were performed. Other CT parameters such as tube voltage, matrix size, FOV, slice thickness and pitch were held constant. Objective image noise in the muscles of two anatomical levels (shoulder and upper neck), radiation dose (CT dose index volume and dose length product), and subjective image quality parameters such as vascular delineation of various arterial vessels, visibility of small arterial detail, image noise and certainty of diagnosis were recorded. The Mann-Whitney U test was used for statistical analysis.

**RESULTS**

Eighteen percent reductions of both CT dose index volume and dose length product were noted with the combined ACTM technique (p < 0.05). There was no significant difference in the objective image noise values of shoulder level between the two techniques, but objective image noise in upper neck was increased significantly with combined ACTM (p < 0.05). There was no difference in subjective image quality parameters between fixed tube current and combined ACTM technique.

**Conclusion**

Combined modulation technique in craniocervical CTA reduces patient’s radiation exposure but maintains its image quality.

**Key Words:** Radiation dose, CT angiography, automatic tube current modulation
acquisition, radiation exposure and scan time can be reduced significantly when compared to multiple dedicated CT acquisitions wherein overlapping regions are exposed to ionizing radiation including the radiation sensitive cornea.

REFERENCES

KEY WORDS: CT, head, postprocessing

Paper 402 Starting at 11:31 AM, Ending at 11:39 AM

Concepts for Blood Velocity Measurements with Multidetector CT

Alhajeri, A. · Anderson, J. · Arbique, G. · Yang, L. · Guild, J. · Lane, T. · Chason, D.

University of Texas Southwestern Medical Center
Dallas, TX

PURPOSE
To investigate the potential application of MDCT to arterial blood flow velocity measurements in the head and neck.

MATERIALS & METHODS
Dynamic MDCT (Toshiba Aquilion 64) acquisitions were made of a phantom simulating bolus flow with a moving steel sphere in a water-filled helical tube. Individual projection views were isolated from the raw CT data. A combination of these views, obtained at 1800 projections per second, with the complete three-dimensional CT reconstruction of the object conceptually allows calculation of the bolus velocity between any two view frames. Back projection of the individual view into the three-dimensional image of the vascular system allows the position of the bolus to be determined. The distance travelled between two views then permits the velocity to be calculated. Recently developed MDCT scanners with extended axial field-of-view (large beam width) and a large number of acquisition channels are required to apply this technique.

RESULTS
Dynamic acquisitions were made on the bolus phantom. From this data the individual projection views were obtained and three-dimensional reconstructions of the entire phantom were generated. The MDCT projection views allowed straightforward visualization of the movement of this well defined bolus with submillisecond resolution. From this velocity of the simulated bolus front was estimated.

CONCLUSION
Advanced processing of the data obtained from dynamic MDCT offers the potential for making blood velocity measurements in the head and neck. Thus MDCT acquisitions could provide not only morphologic data but also functional measurements of the cerebral vasculature.

KEY WORDS: MDCT, blood flow

Paper 403 Starting at 11:39 AM, Ending at 11:47 AM

C-Arm CT Measurement of Cerebral Blood Volume: An Experimental Study in Canines


1University of Wisconsin Hospitals and Clinics, Madison, WI, 2Siemens Medical Solutions, Forchheim, GERMANY

PURPOSE
Angiographic C-arms do not have the ability to acquire rotational acquisitions with a speed adequate to achieve the temporal resolution necessary for determination of cerebral blood flow (CBF). They do provide a means to acquire volume acquisitions before and after contrast administration such that cerebral blood volume (CBV) can be measured. Our purpose was to compare CBV measurements made using traditional CT perfusion techniques (PCT) with those made using C-arm CT.

MATERIALS & METHODS
Under an approved animal protocol five canines were examined using both modalities. Studies were done using endotracheal general anesthesia with constant measurement of heart rate and O2 saturation. Iohexol 300mg/I/cc was used for all studies. PCT was done using a 64-slice V scanner (GE Medical Systems Milwaukee, WI). Two successive PCT studies were done on each animal. First, contrast was injected into a peripheral vein at a rate of 1.5 cc per sec for a total volume of 19 cc followed by a 15 cc saline chase at a rate of 1.5 cc/sec.

For the second study the rate of injection was 1.0 cc per sec for 8 cc and then 0.5 cc for 8 sec again followed by a 15 cc saline chase at a rate of 1cc per second. Images were postprocessed and analyzed on an Advantage Windows workstation. C-arm CT was done using an Artis dBA (Siemens Medical Solutions, Forchheim, Germany). Two studies were done on each animal. First, contrast was injected into a peripheral vein at a rate of 2 cc/sec for 17 seconds followed by a 10 second rotational acquisition. For the second study contrast was injected at a rate of 3cc/sec for 12 seconds followed by a 5 second rotational acquisition. Images were transferred to an X-Workplace for postprocessing and analysis. Input functions for PCT were selected using traditional techniques. Input functions for C-arm CT were selected using MIPs of the reconstructed vascular tree. After CBV maps for each modality had been matched so that anatomical location was the same, ROIs were placed at three locations in each hemisphere on two slices for each study. Size and location of the ROIs was the same, ROIs were placed at three locations in each hemisphere on two slices for each study. Size and location of the ROIs was the same, ROIs were placed at three locations in each hemisphere on two slices for each study. Size and location of the ROIs was the same, ROIs were placed at three locations in each hemisphere on two slices for each study.

RESULTS
Absolute values for CBV made with both modalities were very similar to those reported using PCT in canines. The maximum and mean deviations of values between the two modalities was 27.8% and 9.4%. The maximum and mean deviations between the two PCT studies were 40.7% and 10.0%. The maximum and mean deviations between the two C-arm CT studies were 29.4% and 8.5%.

CONCLUSION
There was excellent agreement between PCT CBV and C-
arm CT measurements. The ability to assess CBV of the entire brain in the angiographic suite should help to optimize management of patients with cerebrovascular diseases.

**KEY WORDS:** Cerebral blood volume

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**Paper 404 Starting at 11:47 AM, Ending at 11:55 AM**

**Dynamic Perfusion CT Assessment of the Blood-Brain Barrier Permeability in Acute Stroke Patients: Delayed Acquisition More Accurate than First-Pass**

Dankbaar, J. W. 1,2 · Hom, J. 1 · Schneider, T. 1 · Cheng, S. 1 · Lau, B. C. 1 · van der Schaaf, I. 2 · Virmani, S. 1 · Pohlman, S. 3 · Dillon, W. P. 1 · Wintermark, M. 1

1University of California San Francisco, San Francisco, CA, 2University Medical Center, Utrecht, Utrecht, NETHERLANDS ANTILLES, 3Philips Medical Systems, Cleveland, OH

**PURPOSE**

To assess which of either the first-pass or the delayed, steady-state, phase of a contrast bolus injection respects the Patlak model assumptions for the assessment of blood-brain barrier permeability (BBBP) best in acute stroke patients using perfusion CT (PCT).

**MATERIALS & METHODS**

Ninety-six nonstroke and 29 acute stroke patients who underwent a specific PCT protocol using a prolonged acquisition time up to 3 minutes were identified retrospectively. The Patlak model was used to calculate the rate constant of contrast leakage out of the vascular compartment. Patlak plots were created from the arterial and parenchymal time-enhancement curves obtained in multiple regions of interest drawn in the infarct core, tissue at risk, and normal brain parenchyma. Linear regression was performed separately for the first-pass of contrast and for the delayed phase. The slope of these regression lines was used as an indicator of BBBP. The Patlak linear regression models for the first-pass and the delayed phase were compared in terms of their respective variances (model mean squared errors, MSE) and regression correlation coefficient (r), by fitting population-averaged clustered data models by using generalized estimating equations with robust variance estimation.

**RESULTS**

Blood-brain barrier permeability values calculated from the first-pass were significantly higher than BBBP values from the delayed, steady-state, phase both in normal brain parenchyma (mean±standard deviation: 4.81±5.42 for the first-pass versus 1.18±0.61 for the delayed phase, p<0.05) and in ischemic tissue (mean±standard deviation: 12.40±20.00 for the first-pass versus 2.38±1.65 for the delayed phase, p<0.05). Compared to regression models from the first-pass, the Patlak regression models obtained from the delayed, steady-state, data were of significantly better quality, showing significantly lower standard deviations of regression errors (square root of MSE) (mean 0.40x10-4 for delayed versus 1.80x10-4 for first-pass, p=0.001) and higher regression correlation coefficients (mean 0.82 for delayed versus 0.59 for first-pass, p<0.001). This was true both for normal brain parenchyma and ischemic tissue.

**CONCLUSION**

Only the delayed, steady-state, phase of the PCT acquisition (and not the first-pass) respects the assumptions of the Patlak model. Applying the Patlak model to the first-pass data results in inaccurate, overestimated measurements of BBBP.

**KEY WORDS:** Stroke, perfusion CT, blood-brain barrier permeability

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**Paper 405 Starting at 11:55 AM, Ending at 12:03 PM**

**Permeability Surface-Area Product Measurements in Brain Tumors Using Perfusion CT: Is There a Role for an Extended Acquisition Time?**

Raffee, S. A. · Ellika, S. K. · Schultz, L. R. · Mikkelsen, T. · Patel, S. C. · Jain, R.

Henry Ford Health System Detroit, MI

**PURPOSE**

There is no real consensus on the optimal acquisition time to measure tumor vascular permeability, especially considering delayed permeability in brain tumors using any of the available in vivo brain perfusion imaging techniques. The purpose of our study was to determine the effect of acquisition time on quantitative measurement of permeability surface area product (PS) and other perfusion parameters using per-
Numerical Perfusion Analysis: From Popular to Optimal

Pianykh, O. S. · Hackney, D. · Raptopoulos, V.
Beth Israel Deaconess Medical Center
Boston, MA

PURPOSE
Perfusion has become one of the most essential tools in brain image analysis. Numerous techniques and flow models have been proposed to compute blood volume (BV), blood flow (BF), and mean transit time (MTT) values from the temporal image data. As a result, in many current applications the perfusion values depend much more on the subjective software and user selections, than on the original data. The purpose of this presentation is to propose a unifying perfusion analysis approach, and to use it for optimizing perfusion accuracy and robustness.

MATERIALS & METHODS
1. We reviewed popular perfusion analysis methods (from early first-moment averaging to current SVD deconvolution) from the computational perspective. We discovered that, despite obvious differences in the underlying models, these perfusion methods have one important common property, that we called Perfusion Linearity Principle (PLP): perfusion values (such as BV) are always computed as weighted averages of pixel intensities: $BV=\sum_{k} W[k] I[k]$, where $I[k]$ is the $k$-th image intensity at the given pixel, and weights $W[k]$ are constant numbers, depending only on the selected method’s parameters, and not depending on the current pixel location. Because of PLP, the choice of weighting coefficients $W=W[1], W[2], \ldots, W[n]$ becomes the only real difference between a variety of existing perfusion techniques.
2. Currently, singular value decomposition (SVD) deconvolution is the most popular and accepted technique for computing perfusion values. We studied 20 brain perfusion sequences (CT) processed with SVD deconvolution, and analyzed their weights $W[k]$, derived from the SVD matrices. 3. We applied PLP to propose the optimal choice of weighting coefficients $W$. This can be achieved with the principal component analysis (PCA). According to PCA, to visualize as many perfusion details as possible, weights $W$ should be chosen as the first vector (first principal component). The resulting first principal component (FPC) perfusion map eliminates the others. 2. SVD tends to assign higher weights to the latest images, than on the original data. The purpose of this presentation is to propose a unifying perfusion analysis approach, and to use it for optimizing perfusion accuracy and robustness.

RESULTS
There were no significant differences for the values of PS, CBV, CBF and MTT between any of the acquisition times. Table 1 contains the results for all tumor patients (n=19), while Table 2 contains the results for the GBMs (n=15).

Table 1: Comparing different acquisition times with perfusion parameters for all patients (n=19)

<table>
<thead>
<tr>
<th>Variable</th>
<th>50 sec</th>
<th>135 sec</th>
<th>170 sec</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS (T) ml/100gms/min</td>
<td>2.55</td>
<td>1.36</td>
<td>1.57</td>
<td>2.36</td>
</tr>
<tr>
<td>PS (N) ml/100gms/min</td>
<td>0.54</td>
<td>0.25</td>
<td>0.70</td>
<td>0.28</td>
</tr>
<tr>
<td>CBV (T) ml/100gms</td>
<td>2.50</td>
<td>1.20</td>
<td>1.18</td>
<td>2.50</td>
</tr>
<tr>
<td>CBV (N) ml/100gms</td>
<td>0.77</td>
<td>0.69</td>
<td>0.82</td>
<td>0.17</td>
</tr>
<tr>
<td>CBF (T) ml/100gms/min</td>
<td>91.29</td>
<td>106.99</td>
<td>52.30</td>
<td>22.63</td>
</tr>
<tr>
<td>CBF (N) ml/100gms/min</td>
<td>28.86</td>
<td>22.34</td>
<td>19.17</td>
<td>21.35</td>
</tr>
<tr>
<td>MTT (T) seconds</td>
<td>4.88</td>
<td>1.12</td>
<td>4.86</td>
<td>1.26</td>
</tr>
<tr>
<td>MTT (N) seconds</td>
<td>5.44</td>
<td>1.91</td>
<td>5.49</td>
<td>2.58</td>
</tr>
</tbody>
</table>

T=Tumor; NAWM=Contralateral Normal-Appearing White Matter

Table 2: Comparing different acquisition times with perfusion parameters for GBM patients (n=15)

<table>
<thead>
<tr>
<th>Variable</th>
<th>50 secs</th>
<th>130 sec</th>
<th>170 sec</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS (T) ml/100gms/min</td>
<td>3.02</td>
<td>1.11</td>
<td>1.75</td>
<td>1.48</td>
</tr>
<tr>
<td>PS (N) ml/100gms/min</td>
<td>0.51</td>
<td>0.26</td>
<td>0.71</td>
<td>0.31</td>
</tr>
<tr>
<td>CBV (T) ml/100gms</td>
<td>2.91</td>
<td>0.98</td>
<td>2.93</td>
<td>1.00</td>
</tr>
<tr>
<td>CBV (N) ml/100gms</td>
<td>0.78</td>
<td>0.09</td>
<td>0.84</td>
<td>0.18</td>
</tr>
<tr>
<td>CBF (T) ml/100gms/min</td>
<td>102.95</td>
<td>117.95</td>
<td>59.05</td>
<td>19.52</td>
</tr>
<tr>
<td>CBF (N) ml/100gms/min</td>
<td>27.32</td>
<td>22.29</td>
<td>19.70</td>
<td>8.36</td>
</tr>
<tr>
<td>MTT (T) seconds</td>
<td>4.83</td>
<td>1.19</td>
<td>4.63</td>
<td>1.17</td>
</tr>
<tr>
<td>MTT (N) seconds</td>
<td>5.61</td>
<td>2.11</td>
<td>5.55</td>
<td>2.65</td>
</tr>
</tbody>
</table>

T=Tumor; NAWM=Contralateral Normal-Appearing White Matter

CONCLUSION
No statistically significant difference was noted in the perfusion parameters especially PS with PCT using an extended acquisition time of 135 or 170 seconds as compared to a 50 second acquisition time. Hence, the role for an extended acquisition time to measure PS, especially to account for delayed permeability in brain tumors, is questionable.

KEY WORDS: CT perfusion, acquisition time, permeability
weighting. Our FPC maps (and their choice of weights W) showed very clear improvements compared to the maps produced by SVD deconvolution.

**CONCLUSION**
The proposed FPC perfusion map provides optimal and robust representation of brain perfusion.

**KEY WORDS:** Perfusion, deconvolution, svd

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**Paper 407 Starting at 12:11 PM, Ending at 12:19 PM**

**Brain Surface Imaging in Combination with Perfusion Imaging of Superficial Tumors with Multidetector CT**

Tsuchiya, K. · Tateishi, H. · Yoshida, M. · Koyanagi, M. · Nitatori, T.

Kyorin University
Tokyo, JAPAN

**PURPOSE**
We assessed the feasibility of brain surface imaging from data of CT angiography (CTA) in combination with perfusion imaging performed on a 64-detector row system.

**MATERIALS & METHODS**
Our patient group comprised 15 patients with a superficial brain tumor (seven with glioma, five with brain metastasis, and three with meningioma) examined on a 64-detector row multidetector (MD) CT. First, we performed precontrast helical scanning of the whole brain to select section levels of perfusion imaging. Second, we performed perfusion CT at four sections that included the tumor using 25 mL of contrast agent (370 mgI/mL) followed by a saline flush of 40 mL. Finally, CTA of the whole brain was performed using 75 mL of contrast agent again followed by a saline flush of 40 mL. These scans were completed within 15 minutes. Postprocessing using a workstation included generating perfusion maps (cerebral blood volume, cerebral blood flow, and mean transit time) and cerebral surface images. The brain surface images were obtained removing scalp and skull from a CTA data set and adding angiographic images obtained after subtraction of a precontrast data set from the CTA data set.

**RESULTS**
In all patients, perfusion maps of the normal brain as well as the tumor were obtained. We also could get surface images that demonstrated the tumor, brain surface, and adjacent arterial cortical branches, cortical veins, and dural sinuses. These images were viewed from any angle and the depth of the image surface could be changed freely.

**CONCLUSION**
Our technique provides not only hemodynamic information of the brain tumor but also anatomical information in a short examination time and a total amount of 100 mL of contrast agent.

**KEY WORDS:** CT angiography, perfusion, neoplasm
Thursday Afternoon

1:30 PM – 3:00 PM
La Louisiane Ballroom

(55) (ASSR) Evaluating and Treating the Patient with Back Pain
Self Assessment Module (SAM)**
Session (AR+)*

(408) – Allan L. Brook, MD
(410) – Blake A. Johnson, MD
(411) – Alyssa T. Watanabe, MD

Moderator: Jeffrey A. Stone, 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 and SAM session programming.

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

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Evaluating and Treating the Patient with Back Pain

Allan L. Brook, MD

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Diagnose, classify and understand treatment options for spinal vascular malformations.
2) Evaluate sacral fractures with the best imaging techniques and therapeutic options.

PRESENTATION SUMMARY
Spinal vascular malformations are rare diseases that are often misdiagnosed until late. They typically lead to progressive myelopathy and spinal cord or nerve root symptoms depending on the location. MRI is the first line of imaging. Recent advances in CTA and gadolinium enhanced MRA help in localization. Spinal angiography is clearly complimentary and is the gold standard to detect the actual fistula site, and allow surgical and endovascular planning. Sacral insufficiency fractures are often under-diagnosed or missed completely upon presentation. They usually present with severe low back or coccygeal pain. Standard radiographs are unable to delineate the fractures unless displaced in the vast majority of cases. MRI elegantly delineates the edema and fracture lines. CT can also delineate fracture site and extent, as well as signs of healing. This in conjunction with nuclear bone scans elucidate the diagnosis as does the MRI. Internal fixation with PMMA has become the standard of care for pain, and to mobilize the patient.

REFERENCES
2. R.W. Hurst MD; L.C. Kenyon, MD, PhD; E. Lavi, MD; E.C. raps, MD; P. Marcotte, MD. Spinal dural Arteriovenous fistula: The pathology of venous hypertensive myelopathy. Neurology 1995 45 1309-1313

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Evaluating and Treating the Patient with Back Pain

Blake A. Johnson, MD

Dr. Johnson is currently Director of Neuroimaging at the Center for Diagnostic Imaging. He completed his undergraduate degree in physiology and his medical degree at the University of Minnesota. After his radiology residency at David Grant Medical Center in California, he completed a 2-year neuroradiology fellowship at the Barrow Neurological Institute in Arizona. He then joined the staff and subsequently was appointed Chief of Neuroradiology at David Grant Medical Center in California. Dr. Johnson also served as Assistant Clinical Professor of Radiology at the University of California, San Francisco, and subsequently as Associate Professor at the University of Minnesota in Minneapolis. Dr. Johnson has authored and co-authored numerous articles and book chapters on neuroradiology topics including spinal imaging and spine injection procedures. He lectures extensively on these areas of interest, and has addressed several national and international forums. His contributions to organizations include serving on the ASSR Executive Committee, the ACR Committees on Economics, Human Resources, Coding and Nomenclature, the CMRS Board of Trustees, the ASNR Committee on Economics, ACR Commission on Neuroradiology and Magnetic Resonance, the ACR Expert Panel on Neuroimaging, the ASNR Research Committee, the ASNR Clinical Practice Committee, Chair of the ASNR Coding & Reimbursement Subcommittee and on the program committees of the ASNR and ASSR. He is currently president of the Clinical Magnetic Resonance Society, a national imaging organization. Dr. Johnson is a three-time recipient of the Editor’s Recognition Award for Distinction in Reviewing for Radiology.

LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Discuss minimally invasive options for the management of neck and low back pain with or without sciatica.
2) Review the mechanisms and therapeutic options for cervicogenic headache.
3) Review criteria and safety considerations for spine interventionnal procedures.
Minimally invasive spinal procedures provide an important contribution to the management of patients with neck, low back and/or radicular pain symptoms. There are multiple structures which may contribute to pain symptoms, and multiple spinal segments may be involved. Although imaging provides invaluable morphologic information, the additional data provided by these procedures through provocative and palliative feedback improve diagnostic accuracy for pain syndromes of spinal origin. For pain management, these procedures provide an alternative to chronic analgesic use or more invasive intervention, such as surgery. In this session, we will summarize some of these options in a case-based format.

**Presentation Summary**

Evaluating and Treating the Patient with Back Pain

Alyssa T. Watanabe, MD

Dr. Watanabe is an Associate Professor of Clinical Radiology at University of Southern California Keck School of Medicine and Director of Spinal Imaging and Interventions, Renaissance Imaging Medical Associates. She is a past President of the American Society of Spine Radiology. Her hospital staff privileges include Century City Doctors Hospital in Los Angeles.

**Learning Objectives**

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

1. Select patients who are candidates for epidural spinal injection.
2. Describe the imaging findings and treatment of spontaneous and postoperative dural leaks.
3. Demonstrate knowledge of different methods for treating symptomatic synovial cysts.

**Presentation Summary**

ESI has now become a widely performed procedure in the United States as a non-operative treatment for low back pain and radiculopathy as well as for other spinal conditions. Patients with lumbar radiculopathy and documented lumbar disc herniation have been shown to have excellent results in one study that was performed on patients who underwent image guided ESI combined with physical therapy. Of those patients, 90-92% reported good to excellent outcome and 92% of patients returned to work. Discussion of various steroid attributes and complications of ESI will be presented. Fibrin glue has been widely used in open neurosurgical procedures and may be effective as an augmentary method in preventing postoperative extradural fluid leakage after dural closures. Percutaneous injection of fibrin sealant can be a successful treatment for dural leaks after spinal surgery as well as for treating recalcitrant CSF leaks due to SIH. The presentation will include imaging and management of patients with dural tears after cervical ACDF, lumbar laminectomy, and posterior instrumentation. Management of symptomatic lumbar synovial cysts may include techniques such as indirect injection via the facet and, if indirect technique fails, direct mechanical cyst rupture. Myelography may be useful to assist in visualization during direct cyst rupture. Moderate sedation during cyst rupture may be useful since patients may feel pressure sensation during a forceful injection into a cyst. Successful cyst rupture is usually evidenced by an immediate loss of resistance during the injection and leakage of contrast into the epidural space.

**References**


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**Thursday Afternoon**

1:30 PM – 3:00 PM

Room 206/207

(56) SNIS Programming: Stroke

(412) Trauma Centers as a Model for Stroke Centers

– Fred A. Mann, MD

(413) Brain Attack Image-Guided Patient Selection

– Ansaar T. Rai, MD

(414) Intracranial Angioplasty and Stenting: Where We’ve Been and Where We’re Going?

– Aquilla S. Turk, DO

Moderator: Philip M. Meyers, MD, FAHA

**Trauma Centers as a Model for Stroke Centers**

Fred A. Mann, MD

Dr. Mann graduated from Purdue University Medical School in 1975 and earned a degree in Internal Medicine from Purdue in 1978. He furthered his education with a degree in Diagnostic Radiology in 1982 from the University of Wisconsin and a Masters of Science in 1999 from the University of Washington, School of Public Health; Seattle, WA. Dr. Mann was employed from 1982-1988 at the University of Utah; 1988-1992 at the Mallinckrot Institute of Radiology; 1992-2007 as the Radiologist-in-Chief; pro-
Dr. Aquilla S. Turk is a diagnostic and interventional neuroradiologist with focus on treatment of cerebrovascular diseases. His main interests are endovascular treatment of cerebral aneurysms and intracranial stenosis. Dr. Turk also is interested in research projects focused on development of next generation coils and stents for aneurysm and ICAD treatment and clinical research centered on neurocognitive improvements associated with intracranial and extracranial stenting. Dr. Turk’s education is as follows: BS in Microbiology from the University of Florida in 1992; DO in

Intracranial Angioplasty and Stenting: Where We’ve Been and Where We’re Going?

Aquilla S. Turk, DO

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Brain Attack Image-Guided Patient Selection

Ansar T. Rai, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Apply technical considerations for perfusion CT imaging.
2) Discuss perfusion parameters such as CBF, MTT and CBV.
3) Utilize perfusion data to select patients for treatment.

PRESENTATION SUMMARY

The purpose of this presentation is to review and discuss imaging techniques that can help identify patients with acute ischemic stroke and direct therapy. The current treatment guidelines for treating acute ischemic stroke are based on the time after symptom onset that a patient presents. These treatment guidelines are based on the NINDS trials published in 1995. Over the years advances in functional perfusion imaging of the brain coupled with the development of multidetector CT scanners has given clinicians an assessment tool that was not previously available when selecting or even diagnosing patients suffering an acute ischemic event. The literature has shown that brain perfusion is dependent on factors that may vary from individual to individual and within the same individual under different conditions. Furthermore, in the setting of an acute ischemic stroke, analysis of brain perfusion parameters can give a picture that is helpful in determining the severity and reversibility of the insult which in turn is critical in selecting patients for treatment. The simultaneous performance of non-invasive angiography, either with CT or MR, allows the anatomic localization of the “lesion”, in this case the site of vascular occlusion. Generally speaking, the CT scanner has a distinct logistical advantage over MRI, in terms of availability, round the clock coverage, ease of use, short scan times which are relatively less dependent on patient motion and finally better spatial resolution. The presentation is organized to give an introduction of perfusion imaging followed by the technical considerations in performing these studies as well as differences amongst different vendors and mainly the role or utility of perfusion imaging and non-invasive angiography in patient selection for treatment. The presentation is heavily illustrated by actual case examples highlighting the role of advanced imaging in individualizing treatment and hopefully improving outcomes.

Presentation Summary

Hierarchical organization of trauma response results in improved patient outcomes within geographically defined regions. Rapid in-field response, stabilization and injury severity-based triage for transport to accredited definitive treatment facilities better matches patient needs to institutional capabilities. System development requires community awareness and support, facility and leadership commitment, professional integrity and partnerships, protocol development and enforcement, and robust institutional and regional quality assurance and process improvement practices. Development of institutional protocols defining procedures to be explicitly followed for suspected acute brain attack victims (“code BART”: Brain Attack Response Team) must assure door to treatment times that initiate treatment within the 3-6 hours from onset of symptoms. For each response, only one team leader can exist. Coordination of stroke team members may be expected to necessitate dedicated multidirectional communication equipment and protocols to initiate and deliver relevant clinical evaluations, laboratory and diagnostic testing, and patient-tailored treatments. Choice of adjunctive imaging (e.g., CT vs. MR) may vary by institution and by immediate availability of equipment (e.g., availability at the time of patient admission vs. usual practices). Elevation of community and first-responder working knowledge of the protean manifestations of acute brain attacks require sustained educational messaging and political finesse. Local media, public schools, community and church groups may all play a role in public awareness. Refocusing or expanding first-responders curricula and competencies may be as much political as educational. Presentation will present brief history of trauma system development; integral (measurable) functions for in-field practices, triage, transport and institutional performances; and, parallels to achieving similar competencies for brain attack.

Learning Objectives

Upon completion of this presentation, participants will be able to:
1) Review logistics needed to achieve timely interventions in acute brain attacks.
2) Extrapolate general model to their practice environments.
3) Select metrics to assess stroke system effectiveness.

LEARNING OBJECTIVES

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1) Review logistics needed to achieve timely interventions in acute brain attacks.
2) Extrapolate general model to their practice environments.
3) Select metrics to assess stroke system effectiveness.

Lecturer of Radiology and Orthopedic Surgery at Harborview Medical Center, University of Washington, Seattle, WA and in 2007 with Seattle Radiologists, APC, Seattle WA. He was also Medical Director, Medical Imaging; Swedish Medical Center - First Hill campus, Seattle. Dr. Mann received the following awards:
1999-2000 President, American Society of Emergency Radiology
2006 Gold Medal, American Society of Emergency Radiology
2006 Faculty of the Year; Department of Radiology, University of Washington; Seattle, WA
2005-2007 “Seattle Best Doctors” recognitions
In 2006 Dr. Man served as Chair, ACR subcommittee (GRP) on Emergency Radiology Dr. Mann has papers appearing in 110 peer-reviewed publications and 18 books/chapters.

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Presentation Summary

Hierarchical organization of trauma response results in improved patient outcomes within geographically defined regions. Rapid in-field response, stabilization and injury severity-based triage for transport to accredited definitive treatment facilities better matches patient needs to institutional capabilities. System development requires community awareness and support, facility and leadership commitment, professional integrity and partnerships, protocol development and enforcement, and robust institutional and regional quality assurance and process improvement practices. Development of institutional protocols defining procedures to be explicitly followed for suspected acute brain attack victims (“code BART”: Brain Attack Response Team) must assure door to treatment times that initiate treatment within the 3-6 hours from onset of symptoms. For each response, only one team leader can exist. Coordination of stroke team members may be expected to necessitate dedicated multidirectional communication equipment and protocols to initiate and deliver relevant clinical evaluations, laboratory and diagnostic testing, and patient-tailored treatments. Choice of adjunctive imaging (e.g., CT vs. MR) may vary by institution and by immediate availability of equipment (e.g., availability at the time of patient admission vs. usual practices). Elevation of community and first-responder working knowledge of the protean manifestations of acute brain attacks require sustained educational messaging and political finesse. Local media, public schools, community and church groups may all play a role in public awareness. Refocusing or expanding first-responders curricula and competencies may be as much political as educational. Presentation will present brief history of trauma system development; integral (measurable) functions for in-field practices, triage, transport and institutional performances; and, parallels to achieving similar competencies for brain attack.

Brain Attack Image-Guided Patient Selection

Ansar T. Rai, MD

LEARNING OBJECTIVES

Upon completion of this presentation, participants will be able to:
1) Apply technical considerations for perfusion CT imaging.
2) Discuss perfusion parameters such as CBF, MTT and CBV.
3) Utilize perfusion data to select patients for treatment.

PRESENTATION SUMMARY

The purpose of this presentation is to review and discuss imaging techniques that can help identify patients with acute ischemic stroke and direct therapy. The current treatment guidelines for treating acute ischemic stroke are based on the time after symptom onset that a patient presents. These treatment guidelines are based on the NINDS trials published in 1995. Over the years advances in functional perfusion imaging of the brain coupled with the development of multidetector CT scanners has given clinicians an assessment tool that was not previously available when selecting or even diagnosing patients suffering an acute ischemic event. The literature has shown that brain perfusion is dependent on factors that may vary from individual to individual and within the same individual under different conditions. Furthermore, in the setting of an acute ischemic stroke, analysis of brain perfusion parameters can give a picture that is helpful in determining the severity and reversibility of the insult which in turn is critical in selecting patients for treatment. The simultaneous performance of non-invasive angiography, either with CT or MR, allows the anatomic localization of the “lesion”, in this case the site of vascular occlusion. Generally speaking, the CT scanner has a distinct logistical advantage over MRI, in terms of availability, round the clock coverage, ease of use, short scan times which are relatively less dependent on patient motion and finally better spatial resolution. The presentation is organized to give an introduction of perfusion imaging followed by the technical considerations in performing these studies as well as differences amongst different vendors and mainly the role or utility of perfusion imaging and non-invasive angiography in patient selection for treatment. The presentation is heavily illustrated by actual case examples highlighting the role of advanced imaging in individualizing treatment and hopefully improving outcomes.

Intracranial Angioplasty and Stenting: Where We’ve Been and Where We’re Going?

Aquilla S. Turk, DO

Dr. Turk is a diagnostic and interventional neuroradiologist with focus on treatment of cerebrovascular diseases. His main interests are endovascular treatment of cerebral aneurysms and intracranial stenosis. Dr. Turk also is interested in research projects focused on development of next generation coils and stents for aneurysm and ICAD treatment and clinical research centered on neurocognitive improvements associated with intracranial and extracranial stenting. Dr. Turk’s education is as follows: BS in Microbiology from the University of Florida in 1992; DO in
LEARNING OBJECTIVES
Upon completion of this presentation, participants will be able to:
1) Understand the natural history of intracranial atherosclerotic disease (ICAD).
2) Review the experience of treating ICAD with balloon expandable stents.
3) Review the current experience of treating ICAD with the Wingspan/Gateway stent system.
4) Review rationale for the upcoming SAMMPRIS trial.

PRESENTATION SUMMARY
Intracranial atherosclerotic disease (ICAD) accounts for up to 10% of the 700,000 new or recurrent strokes that occur in the United States each year. This talk will focus on the natural history and previous endovascular techniques used for the treatment of intracranial atherosclerotic disease (ICAD). We will discuss clinical results of the current generation intracranial stent for ICAD. We also will discuss the rationale for the upcoming SAMMPRIS trial to evaluate stenting against aggressive medical therapy for ICAD.

Thursday Afternoon
1:30 PM – 3:00 PM
Room 208/208

(57) General Session: How I Do It...
Thyroid Lesions and Venous Thrombosis

(415) How to Deal with Thyroid Lesions
   – Laurie A. Loevner, MD

(416) Venous Thrombosis: Diagnosis and Treatment Options
   – Perry Ng, MB, BS, DRANZCR

Moderator: Laurie A. Loevner, MD
Thursday Afternoon

1:30 PM – 3:00 PM
Room 211/212

(58) Advanced Imaging Seminar: Molecular Imaging and Spectroscopy

(417) Advances in Sodium Imaging
  – Keith R. Thulborn, MD, PhD

(418) High Field MRS
  – Michael Tyszka, PhD

(419) Molecular Imaging: Cell Tracking
  – Jeff W. M. Bulte, PhD

Moderators: Timothy P. L. Roberts, PhD
Howard A. Rowley, MD

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Advances in Sodium Imaging
Keith R. Thulborn, MD, PhD

High Field MRS
Michael Tyszka, PhD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1. Understand the core techniques used to acquire magnetic resonance spectra in vivo.
2. Appreciate the strengths and limitations of proton and non-proton spectroscopy in clinical practice.
3. Describe new spectroscopic techniques which are currently transitioning from the research to clinical arenas.

Presentation Summary
In this presentation, we will explore the current state-of-the-art in high field magnetic resonance spectroscopy, with special emphasis on the practical and clinical aspects of the technique. The advantages and pitfalls of increasing field strength for in vivo MRS will be detailed. We will cover the fundamental tools of high field spectroscopy, including single- and multi-voxel spatial localization, solvent suppression and resonance assignment. Clinical areas in which MRS has proved effective will be illustrated, with special emphasis on cancer spectroscopy. The special features of proton and non-proton spectroscopy will be discussed and illustrated with clinically relevant examples. Finally, the potential impact of more recent technical developments such as phased-array spectroscopy, multidimensional correlation spectroscopy and hyperpolarization will be assessed as they transition from research tools to clinical practice.

Molecular Imaging: Cell Tracking
Jeff W. M. Bulte, PhD

Learning Objectives
Upon completion of this presentation, participants will be able to:
1) Describe the advantages and disadvantages of the currently used noninvasive imaging techniques (MRI, PET, BLI) that can be used for cellular imaging in the CNS, in particular as it relates to the sensitivity of detection, obtained resolution, and clinical applicability.
2) Review the differences between labeling and imaging of cells in situ versus ex vivo.
3) Learn how cell therapy may aid in restoring neurodegeneration and how cellular imaging can help to optimize these novel therapeutic paradigms.

Presentation Summary
Because of the limited regenerative capacity of the CNS, there is currently much interest in the development of cell therapies that can support or substitute defunct endogenous cell populations. Therapeutic cells such as stem cells and progenitors can be administered either systemically (intravenous injection) or locally (intraparenchymal or intraventricular grafting). They may improve brain function through several mechanisms: (re)myelination (oligodendrocytes), formation of new synapses (neurons), tissue support (astrocytes), or immunosuppression (neural stem cells). In addition, engineered cells can be used as gene delivery vehicles to induce enhanced protein expression in specific areas of the CNS. Key to successful therapy is the ability of cells to migrate to affected tissue areas and to survive until repair is accomplished. PET and BLI use reporter genes that not only allow imaging of the anatomical location of transfected cells but also can report on actual cell viability. While MRI using superparamagnetic iron oxide-labeled cells allows a very robust detection of the initial migration patterns within gray or white matter it cannot discriminate between live and dead cells and is limited to slowly proliferating cells. While BLI cannot, at present, be applied clinically, both PET and MRI cell tracking studies now have been performed in humans and are on the verge of widespread clinical implementation.
Thursday Afternoon

3:30 PM – 5:00 PM
La Louisiane Ballroom

(59a) ADULT BRAIN: Neoplasms II
(Scientific Papers 420 – 430)

See also Parallel Sessions
(59b) ADULT BRAIN: Vascular: Extracranial
(59c) INTERVENTIONAL: Arteriovenous Malformations, Fistulae, Thrombolysis & Stroke
(59d) SPINE: Spinal Cord Injections & Vertebroplasty II

Moderators: Jacqueline Bello, MD
Sasan Karimi, MD

Paper 420 Starting at 3:30 PM, Ending at 3:38 PM

WNRS Award Winner (2007 Gabriel H. Wilson Award)

Postradiation Treatment Effects vs Tumor Recurrence: Direct Correlation between Histopathology and Perfusion MR Imaging Measurements

Hu, L. S. · Baxter, L. C. · Karis, J. P. · Smith, K. A. · Eschbacher, J. M. · Debbins, J. · Coons, S. W. · Nakaji, P. · Heisermann, J. E.

Barrow Neurological Institute/St. Joseph’s Hospital
Phoenix, AZ.

PURPOSE
Radiation therapy (RT) is part of the multimodality treatment for high-grade gliomas (HGGs). Despite current therapy, tumors often recur. Posttreatment surveillance MR imaging (MRI) plays a major role in following these patients; however, MRI findings are often nonspecific and can represent either tumor, posttreatment radiation effect (PTRE) or a mixture of both. Dynamic susceptibility contrast (DSC) MRI quantifies relative cerebral blood volume (rCBV) as a surrogate marker of tissue microvascular density (MVD) (1,2) and can potentially distinguish between high MVD in tumor growth and low MVD in PTRE to improve diagnostic specificity; however, an examination of the scanty literature available suggests that no group has established threshold rCBV values to accomplish this in clinical practice. The largest study to date (3) analyzed rCBV values in 20 patients clinically diagnosed as having either PTRE or tumor recurrence in order to establish threshold rCBV values which would distinguish the two entities. Unfortunately, they reported a broad range of rCBV values with large overlap between the two patient groups, reducing diagnostic specificity and limiting the clinical utility of their recommendations. Since most of their clinical diagnoses relied on short-term imaging follow up without histopathology confirmation, it is likely that many of the patients in their study were misdiagnosed. We postulate that a project design which directly compares rCBV values with histopathologic diagnosis of PTRE or tumor recurrence will better define accurate threshold rCBV values.

MATERIALS & METHODS
Our study has been approved by the Institutional Review Board. All study subjects have received previous multimodality treatment (including RT) for WHO grade III or IV HGGs and are undergoing surgical resection or biopsy for new enhancing lesions on surveillance MRI. Dynamic susceptibility contrast MRI and stereotactic T1-weighted postcontrast MRI are obtained on a GE 3T scanner prior to surgery. Intravenous gadolinium-DTPA (Gd) bolus (0.05mmol/kg) is injected at 3-5 cc/sec during the T2*-weighted DSC MRI acquisition (TR/TE/flip angle = 2000/20/60°; FOV 24x24cm, matrix 128x128, 5 mm slices), following a preload dose of 0.25 mmol/kg Gd for T1-weighted leakage correction (4,5). During surgical resection, 3-4 tissue specimens (standardized volume of approximately 0.3-0.4 cm³) are obtained from separate regions of abnormal enhancement in each patient for histopathologic analysis. The stereotactic locations of all tissue specimens are documented using the STEALTH® intraoperative neuronavigation system. All data sets are coregistered prior to analysis. Dynamic susceptibility contrast MRI regions of interest (ROIs) (standardized area of approximately 0.8 cm²) corresponding to specimen stereotactic locations yield rCBV values calculated as previously described (4,5). Relative cerebral blood volume values are statistically compared to histopathologic diagnosis of the corresponding tissue specimen.

RESULTS
We have enrolled 10 subjects and documented stereotactic locations of 32 tissue specimens. Histopathology diagnosed PTRE (n=14) or tumor recurrence (n=18). Tumor recurrence rCBV (range = 0.39 to 3.58) was significantly higher than the PTRE group (range = 0.0 to 0.38; p < 0.001), establishing a preliminary threshold rCBV value.

CONCLUSION
These preliminary data support the feasibility of this project design and suggest that rCBV values can differentiate between PTRE and tumor recurrence. Further study is necessary to answer our question definitively. Our overarching goal is to establish a set of clinically applicable guidelines to accurately distinguish posttreatment change from neoplastic recurrence based on rCBV measurements.

REFERENCES

This work is supported in part by internal funding from the Department of Neuroradiology at the Barrow Neurological Institute as well as grant support from the Barrow Neurological Foundation - Women’s Board.

**Paper 421 Starting at 3:38 PM, Ending at 3:46 PM**

Clinical Pathologic Validation of Vendor-Provided Preinstalled MR Imaging Perfusion Sequences at a Nonacademic Regional Center in the Diagnosis of Intracranial Lesions

Safriel, Y.1 2 · Patel, U.2 · Kubal, W.1 · Fulbright, R.1
1Yale University School of Medicine, New Haven, CT, 2Radiology Associates of Clearwater, Clearwater, FL

**Purpose**

Prior reports on dynamic susceptibility contrast (DSC) perfusion have been performed in academic centers using sequences and machines that may have been developed either internally or modified locally and supported by physicists and other support staff. Yet, if perfusion is to enter clinical use, the sequences preinstalled by vendors for use on new MR units shipped to regional nonuniversity imaging centers and hospitals (where patients are often treated and followed up closer to their homes) need to be validated. Therefore, we set out to validate the DSC perfusion sequence preinstalled on the scanner by the MRI manufacturer without modification at a nonuniversity, regional referral center.

**Materials & Methods**

We performed a retrospective review of all cases (reports and images) that underwent DSC perfusion imaging in our institution between November 2006 and November 2007 where either pathologic confirmation of the disease or long-term follow up was available to confirm the diagnosis. The study was based in a nonuniversity, regional neurosurgical institute that is the only neurosurgical center for a population of approximately 1 million people. Perfusion imaging was performed on a 3 T system (Siemens, Erlangen, Germany) using the sequence provided by the manufacturer as part of the commercially available perfusion package. 0.1 mmol/kg of gadopentate (Magnevist, Bayer, Tarrytown, NY) was injected at 4-5 cc/sec via power injector. Postprocessing of rCBV maps was performed on the scanner using the commercially available unmodified software provided with the system by Siemens Medical Systems. Scanning and postprocessing was performed by certified MR technologists who had training provided by the vendor as part of the installation process. An experienced neuroradiologist then validated training and performance. None of the training cases were included in the study.

**Results**

Twenty-one cases were identified that met the inclusion criteria. Pathology confirmed 8 WHO grade III or IV gliomas, 4 metastasis, 2 cases of radiation necrosis, 2 WHO grade II gliomas (infiltrating astrocytoma and oligodendroglioma), and one case each of gliosis and lymphoma. Follow up of two cases of demyelination and one of gliosis versus demyelination documented resolution and stability respectively. In 19 of the 21 cases DSC imaging correctly suggested the diagnosis. In the one discordant case where DSC and conventional imaging predicted a subcentimeter low-grade glioma, the pathologic diagnosis was gliosis and there was suspicion that the biopsy missed the small nonenhancing lesion. The patient declined rebiopsy. In the second discordant case, DSC imaging suggested recurrent nests of an invasive meningioma postradiation but repeat biopsy showed only radiation necrosis. All confirmed gliomas and metastasis had rCBV values between 1.6 and 7 (Mean rCBV=3.8). In the lymphoma case the rCBV value was 1.2. The four nontumor cases all had rCBV values of under 1.3.

**Conclusion**

Vendor-provided perfusion sequences are robust for routine clinical use without modification and deliver results comparable to published data from academic centers in the diagnosis and follow up of intracranial mass lesions.

**Key Words:** MR perfusion, validation, clinical-pathological correlation

**Paper 422 Starting at 3:46 PM, Ending at 3:54 PM**

MR Permeability Imaging in Low-Grade Brain Tumors: Patterns of Maximum Signal Intensity Maps and Correlation with MR Perfusion: Analysis of 12 Patients

Zacharia, T. · Law, M.2 · Leeds, N. E.1
1Penn State Hershey Medical Center, Hershey, PA, 2Mount Sinai Medical Center, New York, NY

**Purpose**

The objective of this study was to study the patterns of maximum signal intensity maps in low-grade brain tumors and correlate with cerebral blood volume (CBV) MR perfusion maps.

**Materials & Methods**

Twelve consecutive patients with low-grade brain tumors were evaluated retrospectively from January 2005 to June 2007. Approval for this retrospective, HIPAA compliant study was obtained from the Institutional Board of Research Associates with waiver of informed consent. All patients (n = 12) had brain biopsy. Histopathologic evaluation was based on the WHO four-tier classification of gliomas: grade II, low-grade astrocytoma (n = 4), grade II, low-grade oligoastrocytoma (n = 1), and grade II, low-grade oligodendroglioma (n = 3), ependymoma (n = 2), and pleomorphic xanthoastrocytoma (n = 2). MR permeability maps were obtained (n = 12) after acquiring T1 postcontrast (TR 500,TE 12) dynamic MR scans (0.1 mmol/kg at a rate of 1 cc/sec). This was followed by MR perfusion scans (n = 12) [dynamic susceptibility contrast imaging (DSC)]. Patterns of MR permeability maps (n = 12) and relative cerebral blood volume (rCBV) maps (n = 12) were calculated using Func
Tool software (GE Health Care, Milwaukee, WI) and these were correlated.

**Results**
A slow rise in MR signal intensity was the most common MR signal intensity pattern observed in eight low-grade tumors (n = 8/12 = 66.6%) and these had a low baseline relative CBV (<1.75) (n = 8). A mixed pattern of rapid rise and slow rise was seen in four low-grade tumors (33.3%) pleomorphic xanthoastrocytomas (n = 2) low-grade oligoastrocytoma (n = 1) and low-grade oligodendroglioma (n = 1) and all these low-grade tumors had a high baseline relative CBV (>1.75).

**Conclusion**
The MR permeability patterns in low-grade brain tumors include “a slow rise pattern” and “mixed pattern of rapid rise and slow rise”. The mixed pattern can be explained by vascular areas such as mural nodule in pleomorphic xanthoastrocytoma that results in focal areas with rapid rise in signal intensity. The mixed rise pattern has a 100% concordance with high baseline relative CBV (>1.75).

**Key Words:** MR permeability imaging, MR perfusion, low-grade brain tumors

**Paper 423 Starting at 3:54 PM, Ending at 4:02 PM**

**Dynamic Susceptibility Contrast MR Imaging in the Evaluation of Recurrent High-Grade Glioma Response to Antiangiogenic Therapy, Bevacizumab and Irinotecan**

Kumar, V. A. · Shah, P. N. · Jung, E. · Knopp, E. A. · Babb, J. · Johnson, G. · Gruber, M. · Zagzag, D. · Narayana, A.

New York University
New York, NY

**Purpose**
Dynamic susceptibility contrast MR imaging (DSC MRI) allows for the in vivo assessment of tumoral response to treatment. Our purpose is to evaluate relative cerebral blood volume (rCBV) and vascular permeability (Ktrans) measurements in assessing the therapeutic response of high-grade gliomas treated with bevacizumab (Avastin), an anti-VEGF monoclonal antibody, and irinotecan (CPT-11), a topoisomerase 1 inhibitor.

**Materials & Methods**
Twenty-eight patients (17 male and 11 female) were treated with one to four cycles of Avastin and CPT-11. The patients were studied with DSC MRI prior to and following treatment. Mixed model regression analysis was used to compare the pre and posttreatment tumoral and peritumoral rCBVs and Ktrans.

**Results**
The tumoral rCBV (t-rCBV) and peritumoral rCBV (pt-rCBV) showed a significant increase over time prior to the initiation of Avastin and CPT-11 treatment (t-rCBV p = 0.0042, pt-rCBV p = 0.0088 respectively). Neither tumoral rCBV nor peritumoral rCBV demonstrated a change over time subsequent to treatment initiation (p>0.39). Although the reduction in rate of change following treatment is not statistically significant, this is the trend favored at this time. Ktrans exhibited no statistically significant change over time in either the tumoral or peritumoral region pre (p>0.26) or posttreatment (p>0.44).

**Conclusion**
We conclude that Avastin and CPT-11 therapy slows the rate of increase of rCBV within the tumoral and peritumoral regions. Relative cerebral blood volume can be used as a surrogate biomarker to follow therapeutic response to Avastin and CPT-11 in treatment of high-grade recurrent glioma.

**Key Words:** Avastin, perfusion, rCBV
Diagnostic Performance of MR Perfusion and 18F-FDG PET in Differentiating Tumor Recurrence from Posttreatment Necrosis

Mangla, R. · Ekholm, S. · Westesson, P. L.
University of Rochester
Rochester, NY

PURPOSE
Differentiation of tumor recurrence from treatment-related necrosis may be difficult with conventional MR imaging when newly enhancing lesions appear. Our aim was to determine the value of perfusion-sensitive dynamic susceptibility contrast MR imaging and 18F-FDG PET for differentiating recurrent neoplasm from nonneoplastic contrast-enhancing tissue.

MATERIALS & METHODS
Thirty-six patients in whom new enhancing lesions developed within irradiated regions were examined with perfusion-sensitive dynamic susceptibility contrast MR imaging. Nineteen of them also underwent 18F-FDG PET within a period of 1 to 25 days. Relative cerebral blood volume (rCBV) ratios and standardized uptake value (SUV) and the tumor-to-normal tissue (T/N) ratio were evaluated to determine whether the new enhancing lesions were recurrent or not. The examinations limited due to artifacts were excluded from the study. The findings on perfusion findings were confirmed histopathologically in 20 patients and PET findings were confirmed in seven patients. In other cases, tumor recurrence was distinguished by lesions that progressively increased in size on serial MR examinations over at least 6 months, and necrosis was distinguished by lesions that disappeared or decreased in size on serial MR studies over at least 9 months.

RESULTS
The receiver operating characteristic curve analysis of each modality was performed. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of dynamic susceptibility contrast imaging was calculated to diagnose recurrence were 83.5%, 75.0%, 76.1%, and 64.4%, respectively. Sensitivity, specificity, PPV, and NPV for determining recurrence on 18F-FDG PET were 78.2%, 55.0%, 62.1%, and 49.2%, respectively.

CONCLUSION
Perfusion-sensitive dynamic susceptibility contrast (DSC) MR imaging and 18F-FDG PET are clinically useful tools to differentiate the tumor recurrence from treatment related necrosis. The rCBV measurements on MR perfusion had better diagnostic performance than the 18F-FDG PET. The major limitation of perfusion imaging is susceptibility artifacts, in such cases 18F-FDG PET may be more useful.

KEY WORDS: 18F-FDG PET, MR perfusion, Posttreatment necrosis

Quantifying Permeability Maps: The Easy Way to Distinguish Radiation Necrosis from Tumor Recurrence

Fatterpekar, G. M. · Delman, B. N. · Gupta, S. · Ando, K. · Law, M. · Naidich, T. P. · Leeds, N. E.
Mount Sinai Medical Center
New York, NY

PURPOSE
Distinguishing tumor recurrence from radiation necrosis can be challenging. The key to distinction lay in assessment of the blood-brain barrier (BBB). Advanced MR imaging techniques including permeability, perfusion and spectroscopy have exploited this and demonstrated promising results toward distinguishing these entities. However, processing usually involves either complex techniques or additional software packages. Our purpose was to quantify permeability maps by deriving an easily reproducible angle between the vascular phase and the extravasation/washout phase of the permeability curve that would reflect tumor angiogenesis, and/or indicate presence of an intact or disrupted BBB to distinguish radiation necrosis from recurrence.

MATERIALS & METHODS
A retrospective analysis of permeability studies was conducted in eight patients, including two patients with radiation necrosis, two patients with GBM, and four with metastasis. Measurements were derived at 24 locations in these patients within enhancing margins. For the first arm of the angle measurement a tangent line (a in figure) was drawn parallel to rapid upstroke of the smoothed curves in the vascular phase. A second line was drawn along either the gradual rise of the curve in cases of extravasation (b on dashed line, type 1) or along the fall of the curve in cases of washout (c on solid line, type 2). Angles formed by these two lines were assessed to evaluate for tumoral angiogenesis and/or BBB intactness. Results were interpreted in conjunction with perfusion studies with regions of interest at comparable locations.

RESULTS
Analysis of angle measurements suggested that more acute
angles reflected disrupted BBB suggestive of radiation necrosis. Thus in type 1 curves, in the nine measurements generated from patients with radiation necrosis, the angle averaged 56.1° (range: 63.4-69.4°). In contrast, the angle averaged 73.7° (range: 70.6-77.7°) in patients with GBM. The angle averaged 70.7° (range: 60.8-77.3°) in patients with metastasis. The type 2 washout corresponded to high perfusion, likely reflecting of tumoral neoangiogenesis. An analysis of this curve demonstrated GBM to have an average washout angle of 94.9° (range: 88.3-101.5°). In contrast, patient with metastasis demonstrated a washout angle averaging 98.4° (range: 90.6-113.0°).

CONCLUSION

The acuteness of the angle can help to distinguish radiation necrosis from recurrence. More acute angles suggest likelihood of radiation necrosis. Presence of a rapid downslope in the permeability curves following the upstroke rules out radiation necrosis and indicates underlying tumor. The washout angle however does not discriminate between various tumors.

KEY WORDS: Permeability, tumor

Paper 426 Starting at 4:18 PM, Ending at 4:26 PM

Characterization of Oligodendrogliomas with CT Perfusion: Comparison with Morphologic Features and Correlation with Histopathology and Genetic Subtypes

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PURPOSE

The purpose of our study was to assess the usefulness of perfusion CT (PCT) parameters especially cerebral blood volume (CBV) and permeability surface-area product (PS) in a) grading of oligodendrogliomas and b) distinguishing molecular subtypes (1p/19q genotype) of oligodendrogial tumors.

MATERIALS & METHODS

Our study included eight patients with treatment naïve oligodendrogliomas. There were six women and two men with a mean age of 46.16 years (age range 35-59 years) and this group was subsequently divided into two groups according to the WHO grading system for oligodendrogliomas into grade II (low-grade oligodendroglioma and oligoastrocytoma; n=4) and those with grade III (high-grade anaplastic oligodendroglioma; n=4) tumors. Perfusion scans were done on 64-slice multidetector row CT scanner. Perfusion maps of CBV, CBF, MTT and PS were generated at an Advantage Windows workstation using CT perfusion 3.0 software. Regions of interest (ROIs) were drawn manually on the PCT maps and absolute values of perfusion parameters within the tumoral ROI were recorded. All patients also underwent preoperative MRI on a 3.0 T magnet (Signa Excite HD, GE, Milwaukee, WI). Two sample tests were done to compare the histopathology and the genotype results with CBV and PS. Descriptive statistics for each parameter were computed for the different groups of patients. Sensitivity/specificity analyses were done to identify cutpoints for the histopathologic groups.

RESULTS

Histopathology vs. PCT: Mean CBV, PS, CBF and MTT did not reach statistical significance in differentiating between the two grades of oligodendrogliomas though the trend was for higher CBV, PS and CBF in the high-grade oligodendrogliomas. A threshold value of 1.11 ml/100gms for CBV provided the highest sensitivity (75%) and specificity (100%) in differentiating low- from high-grade oligodendrogial tumors. A threshold value of 0.62 ml/100gms/min for PS and 25.61 ml/100gms/min for CBF provided sensitivity of 75% and specificity of 75% in differentiating low- from high-grade oligodendrogial tumors. Genotype vs. PCT: There were 6 oligodendrogliomas with loss of 1p and 19q and mean CBV and PS in these patients were 2.92 ml/100 gms (SD=3.63) and 2.20 ml/100gms/min (SD=2.31) respectively which were higher than those with intact 1p and 19q (n=2) in whom the mean CBV and PS measured 1.0 ml/100 gms (SD=0.06) and 0.58 ml/100gms/min (SD=0.06) respectively (p=0.43 and p=0.39, two sample test respectively). CBF and MTT also did not reach any statistical significance in differentiating between the two grades of oligodendrogliomas.

CONCLUSION

Our study has shown that it may be difficult to differentiate the two grades of oligodendroglioma based on CBV and PS though we found that there is a stronger correlation between CBV and oligodendroglioma grade than PS since enhancement in oligodendrogliomas seems to be due more to increase in microvascular density and less to a break in blood-brain barrier. Our study also has shown that CBV and PS may be helpful in differentiation of molecular subtypes of oligodendrogliomas; however further longitudinal studies with a larger patient population need to be done to consolidate our findings.

KEY WORDS: Perfusion CT, oligodendrogliomas, genetic subtypes

Paper 427 Starting at 4:26 PM, Ending at 4:34 PM

Need for Postoperative MR Imaging after Neurosurgical Resection of Malignant Gliomas?

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PURPOSE

CT or MR imaging (MRI) is performed within 72 hours following a neurosurgical resection of a brain tumor. CT is considered adequate as it may rule out space-occupying bleedings in the resection cavity or major strokes. In some cases new neurologic symptoms occur after the resection of a tumor without corresponding imaging findings on CCT.

MATERIALS & METHODS

We analyzed the data of 50 consecutive patients having received an immediate postoperative MRI after the resection of a glioblastoma multiforme (<72 hours) including a diffusion-weighted sequence (DWI), T1 +/- Gd and T2-weighted sequences and a follow-up exam within 90 days. Areas of restricted diffusion were measured. Clinical notes and charts were reviewed.
Areas of restricted diffusion are frequent following neuroabnormality. 15/35 (43%) infarcts. Ten patients had new neurologic deficits postoperatively. In six of these cases the deficits could be explained by the region of postoperative diffusion abnormality.

**RESULTS**

Areas of restricted diffusion are frequent following neurosurgical resection of glioma. Without a DWI sequence minor lesions might be missed that can present as an encephalomalacia with or without enhancement in follow-up MRI. Without knowledge of these lesions new enhancing foci could be misinterpreted as recurrence of the tumor.

**KEY WORDS:** Glioma, MRI, stroke

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**Preoperative Grading of Presumptive Low-Grade Astrocytomas on MR Imaging: Diagnostic Value of Minimum Apparent Diffusion Coefficient**

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**PURPOSE**

The diagnostic value of minimum apparent diffusion coefficient (ADC) for preoperative grading of supratentorial astrocytomas which were diagnosed as low-grade astrocytomas on conventional magnetic resonance imaging (MRI) were accessed.

**MATERIALS & METHODS**

Among 118 astrocytomas (WHO grades II-IV), 16 patients who showed typical MRI findings of low-grade supratentorial astrocytomas on conventional MRI were included. All 16 patients underwent preoperative MRI and diffusion-weighted imaging (DWI). The minimum ADC value of each tumor was determined from several regions of interest in the tumor on ADC maps. To assess the relationship between the minimum ADC and tumor grade, the Mann-Whitney test was performed. A receiver operating characteristic (ROC) analysis was used to determine the cutoff value of the minimum ADC that had the best combination of sensitivity and specificity for distinguishing low- and high-grade astrocytomas.

**RESULTS**

Eight of the 16 patients (50%) who were diagnosed preoperatively as low-grade astrocytomas were confirmed as high-grade astrocytomas (WHO grade III and IV). The median minimum ADC for the high-grade astrocytoma (1.035 × 10⁻³ mm²·sec⁻¹) group was significantly lower than that for the low-grade astrocytoma group (1.19 × 10⁻³ mm²·sec⁻¹) (p = 0.021). According to the ROC, the cutoff value of 1.055 × 10⁻³ mm²·sec⁻¹ for the minimum ADC generated the best combination of sensitivity (87.5%) and specificity (79%) (p = 0.021).

**CONCLUSION**

Measuring minimum ADC can provide valuable diagnostic information for preoperative grading of presumptive low-grade supratentorial astrocytomas.

**KEY WORDS:** Astrocytoma, MRI, diffusion-weighted imaging
Conclusion
Diagnosis of SFT should be evoked for extraaxial, heterogenous, hypervascular tumor, with T2 hypointensity areas and strong enhancement after gadolinium injection.

Key Words: Solitary fibrous tumor, MRI, CT scan
also that during this time tumor markers can remain negative. This rare scenario is known as growing teratoma syndrome, and it usually occurs in retroperitoneal or gonadal locations. Intracranially, it is extremely rare. While there is not enough clinical data here to confirm the diagnosis of growing teratoma syndrome, this case highlights the importance of considering this entity in patients with a history of NSGCT treated with chemotherapy. Imaging is a crucial component of follow up in these patients whose tumor markers may be negative despite residual or recurrent neoplasm.

**Key Words:** Growing teratoma syndrome

**Thursday Afternoon**

**3:30 PM – 5:00 PM**

**Room 206/207**

(59b) ADULT BRAIN: Vascular, Extracranial

(Scientific Papers 431 – 442)

See also Parallel Sessions

(59a) ADULT BRAIN: Neoplasms II

(59c) INTERVENTIONAL: Arteriovenous Malformations, Fistulae, Thrombolysis & Stroke

(59d) SPINE: Spinal Cord Injections & Vertebroplasty II

Moderators: TBD

**Paper 431 Starting at 3:30 PM, Ending at 3:38 PM**

**High-Resolution CT Imaging of Carotid Artery Atherosclerotic Plaques**

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2San Francisco VA Medical Center, San Francisco, CA

**Purpose**
To evaluate the ability of multidetector-row CT angiography (CTA) to assess the composition and characteristics of carotid artery atherosclerotic plaques, using histology as the gold standard.

**Materials & Methods**
Eight patients with transient ischemic attacks who underwent carotid CTA and “en bloc” endarterectomy were enrolled in a prospective study. An ex vivo micro-CT study of each endarterectomy specimen was obtained, followed by histologic examination. A systematic comparison of CTA images with histologic sections and micro-CT images was performed to determine the CT density associated with each component of the atherosclerotic plaques. A computer algorithm subsequently was developed that automatically identifies the components of the carotid atherosclerotic plaques, based on the signal intensity of each pixel. A neuroradiologist’s reading of this computer analysis was compared to the interpretation of the histologic slides by a pathologist with respect to the types and characteristics of the carotid plaques.

**Results**
There was a 72.6% agreement between CTA and histology in terms of carotid plaque characterization. CT angiography showed perfect concordance for calcifications. A significant overlap between densities associated with lipid-rich necrotic core, connective tissue and hemorrhage limited the reliability of individual pixel readings to identify these components. However, CTA showed good correlation with histology for large lipid cores (kappa = 0.796, p<0.001) and wide hemorrhages (kappa = 0.712, p=0.102). CT angiography performed well in detecting ulcerations (kappa = 0.855) and in measuring the fibrous cap thickness (R2 = 0.77, p<0.001).

**Conclusion**
The composition of carotid atherosclerotic plaques determined by CTA accurately reflects plaque composition defined by histology.

**Key Words:** Carotid atherosclerosis, computerized tomography, carotid endarterectomy

**Paper 432 Starting at 3:38 PM, Ending at 3:46 PM**

**Carotid Plaque CT Imaging in Stroke and Nonstroke Patients**

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San Francisco, CA

**Purpose**
To identify a set of computed tomography (CT) features of carotid atherosclerotic plaques that is associated significantly with ischemic stroke.

**Materials & Methods**
In a cross-sectional study, we retrospectively identified 136 consecutive patients admitted to our emergency department with suspected stroke who underwent a CT angiogram (CTA) of the cervical and intracranial carotid arteries. CT angiography studies of the carotid arteries were processed automatically using a custom, CT-based automated classifier algorithm that quantitatively assesses carotid CT features. Acute stroke patients were categorized into “acute carotid stroke patients” and “nonacute carotid stroke patients” independent of carotid wall CT feature, using the Stop Stroke Study Trial of Org 10172 in Acute Stroke Treatment method. Univariate followed by multivariate analyses were used to build models to differentiate between these patient groups and to differentiate between the stroke and unaffected sides in the “acute carotid stroke patients”. A receiver operating characteristic curve analysis determined which model was most accurate.
RESULTS

Forty “acute carotid stroke” patients and 50 “nonacute carotid stroke” patients were identified. Multivariate modeling identified a small number of the carotid wall CT features that were significantly associated with acute carotid stroke, including: wall volume, fibrous cap thickness, number and location of lipid clusters, and number of calcium clusters.

CONCLUSION

Patients with acute carotid stroke demonstrate significant differences in the appearance of their carotid wall ipsilateral to the side of their stroke on CTA, when compared with either nonacute carotid stroke patients or the carotid wall contralateral to the stroke side.

KEY WORDS: CT, plaque, carotid atherosclerosis

Paper 433 Starting at 3:46 PM, Ending at 3:54 PM

Calcium Scoring: Correlation between Bifurcation Calcium Volume and Percent Stenosis of Internal Carotid Artery on Digital Subtraction Angiography

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PURPOSE

Previous research has shown a correlation between calcium volume at the internal carotid origin, and percentage stenosis via postcontrast CT and CTA (1). Our purpose was to determine if a similar correlation exists based on noncontrast CT as compared to catheter digital subtraction angiography (DSA) utilizing NASCET criteria. If so, calcium volumes potentially could be used to screen for carotid stenosis prior to flow limitation.

MATERIALS & METHODS

IRB approval was obtained. The hospital records were reviewed for noncontrast cervical spine CT scans performed over 3 years (2005-2007), in patients >40 years, who also had undergone cervical carotid DSA. Fifty-one patients had both performed for a variety of reasons; the large majority were for traumatic or aneurysm evaluation. Images were obtained with 64- or 4-slice CT scanner and reviewed on a 3D workstation. Calcium volumes at the common carotid bifurcation/internal carotid origin were measured at a predetermined window width/level (30/300). Using NASCET criteria, percent stenoses were determined via DSA. Eighty-eight total carotid bifurcations were reviewed; postsurgical cases or arterial injuries were excluded. >40% stenoses were considered positive. Calcium volume thresholds of 0.01, 0.03, 0.06 and 0.12cc were used for testing.

RESULTS

Patient ages ranged from 41-82 years (mean 59.3). Calcium was measurable on all bifurcations with >40% stenoses. There was moderate correlation between calcium volume and percent stenosis (r = 0.58, p<0.001). The ability of each calcium volume threshold to detect a >40% stenosis was:

<table>
<thead>
<tr>
<th>Calcium Volume Threshold (cc)</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 cc</td>
<td>100%</td>
<td>69.23%</td>
</tr>
<tr>
<td>0.03 cc</td>
<td>100%</td>
<td>85%</td>
</tr>
<tr>
<td>0.06 cc</td>
<td>88.88%</td>
<td>91.13%</td>
</tr>
<tr>
<td>0.09 cc</td>
<td>66.66%</td>
<td>94.87%</td>
</tr>
<tr>
<td>0.12 cc</td>
<td>66.66%</td>
<td>94.87%</td>
</tr>
</tbody>
</table>

The optimum value of calcium volume in detecting percent stenosis was 0.06cc.

CONCLUSION

The moderate correlation noted between calcium volume (on noncontrast CT) and percent stenosis (on DSA) around the carotid bifurcation is in accordance with a previous study that utilized postcontrast CT and CTA (1). Potentially, low dose, noncontrast CT could be used to determine patients at risk for carotid stenosis via semiautomated calcium volume measurements (“scores”). A larger, randomized study could confirm these findings and explore future methodologies of carotid calcium scoring.

REFERENCES


KEY WORDS: Calcium, internal carotid artery, DSA

Paper 434 Starting at 3:54 PM, Ending at 4:02 PM

Evaluation of Carotid Disease Utilizing Dual Energy CT Angiography

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PURPOSE

Three-material decomposition utilizing dual energy (DE) CT can differentiate soft tissue, contrast agent and bone, allowing automated segmentation and removal of osseous structures. When evaluating the carotid arteries, identification of calcium and the potential to remove calcified atherosclerotic plaque allows for improved visualization of the contrast-filled lumen for more accurate assessment of stenosis. We report our initial experience and challenges utilizing DE CT angiography (CTA) to evaluate carotid disease.
Patients were imaged on the SOMATOM Definition CT (Siemens Medical Systems, Forchheim, Germany) in DE mode (140 kV and 80 kV). Bolus tracking was used to initiate scanning after intravenous contrast administration. Postprocessing to generate bone removed images was performed on the Siemens MultiModality Workplace utilizing the DualEnergy application. Maximal intensity projection and volume rendering technique reconstructions were generated using InSpace. Measurements of atheromatous plaque and luminal diameter were performed in a bi-orthogonal manner.

RESULTS
Twenty-one DE CTA studies were evaluated, which included: carotid stenosis (18), carotid dissection (1), carotid pseudoaneurysm (1), and carotid body tumor (1). One patient with carotid stenosis had undergone carotid stent placement. Utilizing automatic bone removal practically eliminated the calvarium, skull base and cervical spine in all exams. Fine adjustment of the initial subtraction was necessary to optimize the degree of subtraction for the area of interest. The optimized images demonstrated carotid disease equal to or better than reconstructions performed without subtraction. Inherent blooming artifacts present in the images limit the accuracy of assessing hard plaques in smaller vessels. One limitation of the method that we encountered in the initial software version was the rather aggressive removal of calcified plaque. However, refinement of the algorithms in the most recent version improved visualization of plaques. Overall, there was a mean over-subtraction of 28% of the area of calcified plaque surrounding the segment of greatest stenosis. The resultant change in luminal diameter varied depending on the amount of soft plaque separating the hard plaque from the lumen and ranged from 0.0 to 1.4 mm. There was apparent occlusion of two vessels which, after review of the source data, showed high-grade stenosis surrounded by densely calcified plaque. Optimal contrast bolus timing and the degree of intrinsic noise were important factors in determining subtraction quality. Adjustments to standard CTA protocols were needed to compensate for differences in tube voltage during monitoring for bolus tracking. Streak artifact and scatter, particularly from dental amalgam, also affected subtraction results for portions of the artery. Additionally, evaluation of the stented carotid lumen was improved by the inherent increased attenuation of iodinated contrast material at 80 kV. This allowed better visualization of the opacified lumen on multiplanar images; a potential advantage for evaluation of in-stent stenosis.

CONCLUSION
DE CTA with automated bone/calcium removal to depict vascular pathology does enhance evaluation of many types of carotid disease. However, we suggest that morphologic measurements should be performed on the original CTA data. Potential future applications would include evaluation of intracranial vascular disease, where automated bone removal would greatly enhance visualization.

KEY WORDS: Dual energy CT, carotid stenosis

Energy Discriminating, Photon Counting CT Scanner Evaluation: Initial Clinical Experience

Patients with known carotid artery stenoses confirmed by Doppler ultrasound and admitted for carotid endarterectomy were enrolled into the study. All patients underwent CTA exam of the neck. The CT scanner has been assembled with an energy-discriminating photon counting detection system. Selected patients also underwent DSA examination. Scanning parameters include 140 kVp, 30 and 50 mA, 1 second gantry rotation, and pitch = 0.5. The data acquired from the newly developed detectors were used to produce total, high, and low energy image sets as well as mono-energetic equivalent images. Image processing includes volume rendering, MPR, and curved oblique. All images were reviewed by experienced neuroradiologist and assessed for image quality and the stenosis degree of the carotid artery. The stenosis degree of images with DSA counterpart then was compared.

CONCLUSION
The new energy discriminating photon counting CT system produces CT images of diagnostic quality. Considering the low mA technique used in the scans, excellent visualisation of soft and hard plaque components and accurate assessment of stenoses was achieved. The Mono-energetic images provide a new window paradigm adding useful information for the evaluation of vascular stenotic disease.

KEY WORDS: Energy discriminating CT, photon counting CT, CT angiography
Can Contrast Management in Neuro CTA be Improved by Advancing the Site of Bolus-Triggering from the Aortic Arch to the Pulmonary Artery? Assessment of the Consistency of the Extra Lead Time Available for Bolus-Shaping

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PURPOSE
Reducing CTA contrast dose is desirable as long as sufficient opacification is maintained. This can be accomplished by raising injection rate accordingly though this tends to hasten bolus arrival in the target vessels. When bolus-triggering from the standard location in the aortic arch (AA), a too-fast bolus may arrive earlier than the time necessary for current scanners to reposition and transition from monitoring to scan modes. We hypothesize an earlier trigger at the pulmonary artery (PA) could provide the sufficient lead time to benefit from a faster bolus. Given a potentially diseased heart interposed between potential PA and AA triggers, we sought to determine if the added time interval would be consistent enough from patient-to-patient for reliable scan planning.

MATERIALS & METHODS
We retrospectively analyzed 59 neuro CTAs performed in a stroke population with a standard 64-slice MDCT protocol. Patients were divided into three groups: no cardiac disease (n=39), any cardiac disease (n=20), and those with documented low ejection fraction (EF) (n=3). Density ROIs in the PA and 50 HU in the AA were collected from each image of the triggering series. Designating a 100 HU rise as the hypothetical trigger in the PA and 50 HU in the AA, we calculated the time interval between when each threshold was reached.

RESULTS
In all patients, mean time interval between PA and AA triggers was 4.8s (sd 2.6) with a small coefficient of variation (cv 0.54). No significant difference (p=0.083) between cardiac disease and noncardiac disease groups was observed (mean 5.5s sd 2.6 vs. 4.3s sd 2.5). Also, neither group had a large internal variability (cv 0.57 vs. cv 0.47). The small subgroup of patients with low EF (n=3) did have a prolonged mean interval though it was tightly distributed (mean 7.3s sd 0.57, p=0.02, cv 0.08).

CONCLUSION
Mean added time (~5 seconds) gained from bolus-triggering from the PA appears to be consistent whether was no cardiac disease or cardiac disease without known decreased EF. Clinical relevance/application: The added time interval theoretically can be used to improve contrast management and scan quality. These results are a reasonable basis for a prospective study of PA bolus-triggering for neuro CTA.

KEY WORDS: CTA, bolus-shaping, contrast
CONCLUSION
Our phantom study indicated that the radiation dose of MDCT angiography can be reduced by 25% without loss of image quality with regard to the depiction of the simulated bleb by applying the QDS using the higher-frequency sharpening processing.

KEY WORDS: CT angiography, edge-preserving adaptive filter, intracranial aneurysm

Paper 438 Starting at 4:26 PM, Ending at 4:34 PM
Endovascular Management of Inoperable Meningioma

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PURPOSE
To determine the efficacy of ethanol embolization of single and multiple meningiomas in poor surgical candidates.

MATERIALS & METHODS
Eleven patients (8 female, 3 male; mean age 52 years) underwent clinical, MR, and angio evaluations. In patients who had postsurgical recurrence and/or were poor operative risks, ETOH embol was offered as an alternative procedure. Two patients had multiple meningiomas related to Von Recklinghausen’s Neurofibromatosis Type II.

RESULTS
All patients underwent ethanol embolization of single and multiple pedicles supplying the tumor. Four patients suffered complications (1 patient minor late SAH without sequelae, 2 patients transient 6th nerve palsy, 1 patient transient worsening of aphasia). MR imaging and CT demonstrated significant necrosis and shrinkage of the tumors at long-term follow up (range: 6-72 mos; mean: 30 mos).

CONCLUSION
ETOH, being a liquid agent, penetrates to the capillary level causing necrosis and exclusion of collateral flow. This leads to tumor necrosis and shrinkage. Taking advantage of the slow-growing, nonmetastasizing characteristics and increased vascularity of this tumor, ETOH is an attractive alternative therapy that is minimally invasive. This treatment can be offered in selected poor surgical patients. This procedure is efficacious in highly vascular tumors and in poorly vascularized meningiomas not possible to treat surgically.

KEY WORDS: Meningioma, ethanol, embolization

Paper 439 Starting at 4:34 PM, Ending at 4:42 PM
3 T Vessel Wall Imaging of Cervical Artery Dissection

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PURPOSE
The aim of this study was to assess the utility of 3 T vessel wall imaging (VWI) to aid the diagnosis of cervical (vertebral and carotid) artery dissection, in particular in the evaluation of primary intramural pathologic changes.

MATERIALS & METHODS
Nineteen patients with clinically suspected vertebral (n=12) or carotid (n=7) dissection, confirmed by CT angiography (CTA) underwent 3 T VWI (T1 DIR, T2* GE, 2D TOF MRA) with prototypical 4-channel surface coil. Blinded observers reassessed CT (n=1) or MR (n=2, by consensus) images for luminal (flap, hematoma, stenosis) and wall changes (thickening, signal change) in all four cervical vessels. Vessel wall imaging from four normal volunteers also was assessed. Follow-up imaging was obtained where possible.

RESULTS
Cervical artery dissection was identified in 25 arteries (15 vertebral; 10 carotid) on VWI and 21 arteries on CTA (14 vertebral 7 carotid). Luminal changes: a flap was seen in 15 dissected vessels (vertebral: 7; carotid: 8) on VWI and 7 vessels on CTA (vertebral: 4; carotid: 3). Either stenosis (vertebral: VWI - 10, CTA - 11; carotid: VWI - 7, CTA - 5,) or occlusion (vertebral: VWI - 5, CTA - 4; carotid VWI - 2, CTA - 3) was demonstrated in the majority of vessels on both modalities. Mural changes: wall thickening was seen in 24/25 vessels on VWI (vertebral 14, carotid 9) and 20 vessels on CTA (13 vertebral, 7 carotid). All cases showed mural signal change on VWI and we were able to differentiate this from intraluminal thrombus; in 17/25, it reflected mural hematoma, sometimes further localized as intramedial or subintimal, which could be associated with a “target sign”. In 16 cases, including all 10 carotid dissections asymmetric “periadventitial” thickening and signal change was seen, particularly on T2* sequences, which was thought to represent local edema. [The image (below) demonstrates both “target sign” and periadventitial signal change in relation to the left vertebral artery]. No such changes were seen in normal volunteers.
CONCLUSION
The high diagnostic accuracy of CTA is supported by this study; however, VWI, with its superior contrast resolution, allows us to visualize not only more dissection flaps, but also more detailed pathologic changes within the vessel wall. Vessel wall imaging commonly shows edema surrounding a dissecting vessel, a novel observation, which may represent a local inflammatory response. Vessel wall imaging may be useful in diagnosing difficult cases of dissection.

KEY WORDS: Vertebral, carotid, dissection

Paper 440 Starting at 4:42 PM, Ending at 4:50 PM
Low Complication Rate for Carotid Stenting in Real-Life Clinical Settings

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Napoli, ITALY

PURPOSE
A paradigm shift recently has been proposed by Roubin and coworkers for carotid stenting to reach its full potential in primary and secondary prevention of stroke. The pivotal issue resides in attaining and consistently maintaining an acceptable risk of periprocedural complications (3% or less). As it has been demonstrated by Wennberg and coworkers that the mortality rate is higher in Medicare patients undergoing endarterectomy than in subjects enrolled in clinical trials, it could be inferred that any carotid revascularization procedure should be evaluated in real-life settings. Our results in patients undergoing carotid stenting in such settings are reported here.

MATERIALS & METHODS
From July 2003 to October 2007, 78 carotid stenting procedures were performed in 70 consecutive patients (age: 42-87 years; M: 50, F: 20) harboring atherosclerotic plaques. Five of them were octogenarians.

RESULTS
Successful carotid revascularization was obtained in all cases. One patient (overall rate: 1.4%) suffered complications. Specifically, a disabling and, in the long run, fatal embolic stroke.

CONCLUSION
Large clinical trials have defined candidates to carotid revascularization, but controversy exists in the field of indications and merits of endarterectomy or carotid stenting, respectively. Our data are in keeping with those reported by nonrandomized studies which attained the best results. While reasons to refrain from antiplatelet agents are the contraindications most often encountered, decreased cerebral reserve, lack of collateral blood supply, vascular tortuosity, heavy plaque calcification and vulnerable plaques add to technical difficulties and call for a case-by-case evaluation. Elderly patients have a higher incidence of unfavorable anatomy as well as comorbidities, but age should not be regarded as a contraindication in itself. Nowadays, embolic protection devices are to be considered the standard of care, but they cannot prevent all embolic complications nor be a surrogate for careful technique. Moreover, patient monitoring and care must take into account also nonembolic causes of stroke. As already pointed out by Roubin and coworkers, referring patients for stenting only because they are at high risk for open surgery is a conventional but inadequate paradigm, arbitrarily implying that stenting is just a low risk procedure. On the contrary, it is of crucial importance to recognize the specific problems and intricacies posed by carotid stenting. In each patient, it is mandatory to evaluate whether the risks of procedure-related adverse events outweigh those of ipsilateral stroke with long-term medical therapy. Everyday clinical decision-making should incorporate these principles. Appropriate risk stratification and facile procedural technique are to be implemented for stenting to fulfill the promise it holds for stroke prevention.

REFERENCES

KEY WORDS: Carotid artery stenting, carotid stenosis, angioplasty and stenting

Paper 441 Starting at 4:50 PM, Ending at 4:55 PM
Improved Cognitive Function after Simultaneous Bilateral Carotid Artery Stenting

Eesa, M. · Demchuk, A. M. · Hill, M. D. · Sharma, P. · Goyal, M. · Hudon, M. E. · Morrish, W. F. · Wong, J.
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Calgary, AB, CANADA

PURPOSE
The efficacy of carotid revascularization procedures has been studied traditionally using end-points such as stroke, myocardial infarction and death. Its role in improving cognitive function is being recognized increasingly. We describe a case in which there was improvement in vascular cognitive impairment (VCI) in a patient following simultaneous bilateral carotid stenting.

CASE REPORT
A 79-year-old lady presented to the neurology service with history of recurrent TIAs. She also had a severe cognitive decline determined by mental status examination for the preceding 4 months. Her CT angiogram revealed severe bilateral carotid stenosis (Fig 1A). Since she was a high surgical risk, it was decided to treat by an endovascular approach.

IMAGING FINDINGS
The patient was admitted for the procedure. Preprocedural MRI confirmed the presence of infarcts involving bilateral deep watershed distribution. She had an incomplete circle of Willis and it was thought that the chronic hypoperfusion from bilateral disease contributed significantly to her cogni-
tive decline and a decision to treat both carotid arteries was taken. Angioplasty and stenting of bilateral internal carotid arteries was performed successfully under local anesthesia and conscious sedation (Fig 1B). There was no intraoperative hemodynamic instability and the patient made an uneventful recovery. The patient was seen in clinic at follow up and showed improvement in cognitive function as determined by the mental status examination. The procedure therefore in addition to improving the neurologic outcome also helped improve cognitive function.

SUMMARY
Vascular cognitive impairment in cerebral ischemia may be compounded by chronic hypoperfusion from bilateral carotid stenosis. When clinically and technically feasible, simultaneous stenting procedures in nonsurgical patients can help improve cognitive function.

REFERENCES

KEY WORDS: Angioplasty, cognitive function, carotid

Basilar Artery Rapid Clot Removal for Acute Stroke Therapy

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PURPOSE
Endovascular therapy in acute ischemic stroke offers hope to patients who do not meet the strict inclusion criteria to be given intravenous tissue plasminogen activator, the current standard of care. Because no single approach or device can be effective in every patient, multiple options are desirable.

Direct mechanical removal of clot has both theoretical (removal of a thrombin load) and practical (rapid reestablishment of blood flow) advantages. We report a retrieval device which proved effective in quickly reestablishing flow, and improving our patient outcome.

MATERIALS & METHODS
A 48-year-old male with past medical history of hypercholesterolemia, presented to our institution with acute onset of neurologic symptoms that pointed to posterior circulation ischemia; his deterioration occurred 2.5 hours before hospital admission. Symptoms included lack of lateral gaze and dysarthria with an overall National Institute of Health (NIH) stroke scale of 7 on admission. Upon arrival at our angio suite, the patient had been treated by a qualified stroke neurologist with intravenous tissue plasminogen activator, without improvement. Unenhanced CT and CT angiogram revealed basilar artery occlusion. Our diagnostic angiography confirmed a distal basilar artery occlusion, but the carotid artery injections showed only trivial posterior communicating arteries. We first attempted clot removal with the neuronet device, obtaining significant recanalization of the basilar artery, then performed further mechanical thrombus removal with the Merci device. No pharmacologic agent was administered in the angio suite.

RESULTS
With the Neuronet device, we were able to recanalize the basilar artery relatively rapidly, and subsequent passages of the Merci device improved flow even further, especially in the distal basilar artery. At the completion of the procedure, the angiogram demonstrated patency of the basilar artery. Good runoff was present in the posterior cerebral arteries bilaterally despite residual luminal thrombus. Over the course of the days following our procedure, the patient had a dramatic neurologic recovery with only minimal residual deficits related to a small left posterior cerebral and right superior cerebellar infarcts. Twenty-day follow-up MRA showed patent and normal-appearing basilar artery and bilateral posterior cerebral arteries.

CONCLUSION
Basilar artery thrombosis has uniformly poor outcomes unless rapid reestablishment of blood flow occurs. Despite the failure of intravenous tissue plasminogen activator, we mechanically reopened the basilar artery and reestablished flow. We believe that the ability to combine multiple extraction devices with appropriate plasminogen activators and clot inhibitors will ultimately lead to the best clinical outcomes.

KEY WORDS: Basilar artery, acute occlusion, mechanical thrombectomy
Histopathologic Changes in Brain Arteriovenous Malformations After Embolization with Onyx® or n-BCA

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PURPOSE
To analyze the histopathology of a consecutive series of 32 patients of brain AVMs resected after endovascular embolization (21 with Onyx® and 10 with n-BCA).

MATERIALS & METHODS
Selections from fixed paraffin embedded specimens were stained for histologic examination with hematoxylin-eosin and Verhoeff-van Gieson. Lipid dye Oil-Red-O was used to stain vessel specimens, which were embolized with a n-BCA. Specimens were evaluated for presence of embolic agent, inflammation, angionecrosis, and evidence of recanalization (endothelial lined spaces within a fibrosed embolic cast). These results were correlated with the time interval between the bleed, embolization and surgical resection.

RESULTS
There was evidence of vascular/ perivascular inflammation in 19/21 (90.5%) and 9/10 (90%) of specimens after Onyx® and n-BCA embolization respectively. There was evidence of recanalization in Onyx® embolized vessels in 5/21 (23.8%) specimens, whereas there was no evidence of recanalization after n-BCA embolization.

CONCLUSION
Inflammation and angionecrosis after embolization show that embolic agents are not inert. Evidence of chronic foreign body giant cells and recanalization after Onyx® embolization shows long-standing reaction to Onyx® and question the permanence of occlusion after Onyx® embolization. Surgical resection of the AVM is recommended despite apparently complete angiographic embolization due to these factors.

KEY WORDS: AVM, Onyx, pathology

Paper 444 Starting at 3:38 PM, Ending at 3:46 PM
Interest of Onyx in the Endovascular Treatment of Cerebral Arteriovenous Malformations Inside a Pluridisciplinary Center

Tahon, F. · Amsalem, Y. · Belmar, A. · Salkine, F. · Pelissou-Guyotat, I. · Sindou, M. · Mottolese, C. · Favrel, V. · D’hombres, A. · Turjman, F.
'hopital Neurologique et Neurochirurgical, Bron, Lyon, FRANCE, 'hopital Lyon Sud, Bron, Lyon, FRANCE

PURPOSE
The purpose of this study is to report the management of 58 patients with cerebral arteriovenous malformations (cAVMs) treated at least once by Onyx, all patients having a complete management of their cerebral arteriovenous malformations.

MATERIALS & METHODS
All patients in this series were admitted to our institution with cAVMs suitable for endovascular treatment. Between 2003 and March 2006, 58 patients (39% women and 61% men), mean age 35.8 years were embolized at least once by Onyx. Clinical presentations include hemorrhage 23 (40%), seizure 19 (32.6%), neurologic deficit 2 (3.4%), incidental finding 14 (24% with headaches 7 = 12%). According to the Spetzler-Martin Grading Scale, 9 (15.5%) patients were ranked as grade I, 20 (35.3%) as grade II, 19 (33%) as grade III, 9 (15.5) as grade IV and 1 (1.7%) as grade V; mean estimated volume of cAVM was 28.3 mL (range 0.5-145 mL) before embolization (according to Pasqualin’s method).

RESULTS
A total of 168 feeders were embolized. In 99 (59%) feeders we used Onyx and in 69 (41%) N-butyl cyanoacrylate. The number of cAVM embolized with Onyx as the only embolic agent was 19 (33%). The average reduction in volume after embolization was 92.3% (range 33-100%); < 50%, 1; 50-75%, 4; 76-89%, 5; 90-95%, 15; 96-99%, 8. Total obliteration by embolization alone was achieved in 17 (29.3%) patients and by combination of embolization and surgery in 10 (17.2%). In 27 (46.5%) patients, a radiosurgery was planned and in four (7.0%) patients the treatment was stopped. Those data refer to angiographics control done after the last embolization (available in all patients) and to follow-up examination available in 33 (57%) patients (average follow-up time 12.5 months). Technical complications occurred
in 6% of feeders’ embolization without clinical consequence. Procedure-related permanent neurologic deficits occurred in four (6.9%) patients. There were two procedure-related deaths (3.4%).

**Conclusion**

In our experience the average volume reduction was 92.3% and complete obliteration by embolization alone in 29.3%. Knowing the cAVMs anatomy and the Onyx characteristic allows us to achieve a high cure rate with a low complication rate in embolization of a small number of feeders.

**Key Words:** Cerebral AVM, management, Onyx

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**Paper 445 Starting at 3:46 PM, Ending at 3:54 PM**

**Transarterial Embolization of Cranial Dural Arteriovenous Malformation in 11 Patients Using Onyx**

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Birmingham, UNITED KINGDOM

**Purpose**

Endovascular treatment of cranial DAVM has been accepted practice. Most centers use platinum coils or N-butyl-cyanoacrylate for this treatment. We evaluated the technical aspects, efficacy and safety of endovascular infusion of Onyx as an alternative primary treatment.

**Materials & Methods**

We did a retrospective analysis of 11 patients with cranial DAVF who were treated in our institution, a tertiary neurosciences unit over a 24-month period (year 2006-07). Clinical and radiologic data were reviewed.

**Results**

Eleven patients with a mean age of 58 years and a male: female ratio of 3:4 were identified. Spontaneous sudden onset tinnitus in five, intracranial hemorrhage in three, hydrocephalus in one, ataxia one, global amnesia one. Five patients had Cognard Type 1, one had Type 2, and five had Type 4. Onyx was the sole embolic material used in 10 patients. Platinum coils were used in addition to Onyx in one patient. Transarterial route was chosen in all treatment procedures, except in one, where closure was achieved during a third stage procedure via transvenous approach from direct internal jugular puncture. Angiographic obliteration was achieved in all patients. Complete obliteration was achieved in a single treatment procedure in eight patients, a second stage procedure was necessary in three patients. All patients are asymptomatic following completion of treatment. Complications: one patient suffered third nerve palsy following embolization of cavernous DAVM.

**Conclusion**

In this small series, endovascular infusion of Onyx proved to be a safe and effective option in the treatment of cranial dural arteriovenous fistulae of various types.

**Key Words:** Dural AVMs, cranial, Onyx

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**Paper 446 Starting at 3:54 PM, Ending at 4:02 PM**

**Transarterial Endovascular Treatment Using Ethylene Vinyl Alcohol Copolymer in Intracranial Dural Arteriovenous Fistulas with Leptomeningeal Venous Drainage**

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**Purpose**

Dural arteriovenous fistulas (DAVFs) with a leptomeningeal venous drainage are lesions associated with an aggressive natural history and poor prognosis. The treatment of these lesions is mandatory. The purpose of our study was to report our experience in transarterial embolisation using Onyx in this type of DAVF.

**Materials & Methods**

Retrospective chart analysis and radiologic studies evaluation were carried out in 12 patients with a DAVF with a cortical venous drainage treated by transarterial embolization using Onyx 18. There were nine men and three women ranging in age from 46 to 60 years. Clinical findings included hemorrhage in six patients, symptoms of raised intracranial pressure with visual impairment in three, bruit and headache in one and in two patients the DAVF was diagnosed by chance (associated with an AVM remote from the DAVF in one patient and with a vestibular schwannoma in the other one). The DAVFs were located at the transverse sinus (n = 3), at the superior sagittal sinus (n = 2), at the superior petrosal sinus (n = 1), in the tentorial region (n = 4) and in the posterior fossa (n = 2). Endovascular treatment was performed using only Onyx in 10 cases, Onyx and glue in 1 and Onyx and coils in another one.

**Results**

Complete anatomical exclusion of the DAVF was achieved in 10 cases and two patients, in whom a significant reduction of the lesion was obtained after the first procedure, are scheduled for a further session. In eight cases, the complete occlusion of the fistula was obtained in one session. After embolization, eight patients (including six who recovered from the hemorrhage) remained asymptomatic. Four patients with symptoms of raised intracranial pressure and/or bruit and headache were cured clinically. No clinical complications were observed in this series. Onyx allowed to perform prolonged injection of the material under angiographic control and to obtain a good filling of the dural shunts with progression in the primary venous drainage.
**CONCLUSION**
In our experience, Onyx 18 is a safe and efficacious tool in the treatment of DAVFs with a leptomeningeal venous drainage. At the present time transarterial embolization with Onyx is the best treatment in most of these lesions.

**KEY WORDS:** Fistula, arteriovenous shunts, embolization

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**Paper 447 Starting at 4:02 PM, Ending at 4:07 PM**

**Obliteration of a Dural Arteriovenous Fistula Using a Double-Catheter Technique**

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**PURPOSE**
We present a double-catheter technique with the use of Onyx 34 and Onyx 18 (EV3, Irvine, CA) for the treatment of a complex dural arteriovenous fistula (DAVF).

**CASE REPORT**
A 60-year-old with intractable tinnitus on the left was found to have a tentorial DAVF supplied primarily by transosseous branches of the left occipital artery, but also the right occipital artery, petrosal branches of the left middle meningeal artery, the left anterior interior cerebellar artery, the left posterior inferior cerebellar artery, the posterior meningeal artery, and the right and left meningo hypophyseal trunks. Treatment options considered were direct puncture, foramenal approach, and the double-catheter technique. We placed a 7 French, 70 cm Raabe sheath (Cook, Bloomington, IN) in the left common carotid artery and a 6 French guider catheter in the left external carotid artery. We then placed an Echelon 10 microcatheter (EV3, Irvine, CA) into the transosseous segment of the left occipital artery distally and a second Echelon 10 microcatheter proximally in the transosseous segment of the left occipital artery. This proximal microcatheter was injected with 1 vial of Onyx 34 to develop a 10-15 mm plug. Superselective angiography was performed through the distal microcatheter demonstrating flow arrest. 0.33 cc of DMSO was infused through the distal microcatheter followed by 5 vials Onyx 18. This achieved complete obliteration of the tentorial DAVF with no appreciable reflux.

**IMAGING FINDINGS**
The left tentorial dural arteriovenous fistula was completely obliterated with Onyx 18 infusion through a distal microcatheter in a transosseous branch of the left occipital artery following development of a 10-15 mm plug of Onyx 34 proximally in the same transosseous branch of the left occipital artery.

**SUMMARY**
This case demonstrates the value of Onyx 34 in achieving a proximal 10-15 mm plug utilizing a double catheter technique in preventing reflux during infusion of Onyx 18 for the treatment of a complex dural tentorial arteriovenous fistula.

**KEY WORDS:** Dural arteriovenous fistula, Onyx

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**Paper 448 Starting at 4:07 PM, Ending at 4:12 PM**

**Documented Development of Dural Arteriovenous Fistula in an Infant Subsequent to Sinus Thrombosis**

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**PURPOSE**
To demonstrate the development of an acquired DAVM in an infant following dural sinus thrombosis.

**CASE REPORT**
A 5-month-old infant presented to the hospital with lethargy and decreased responsiveness. CT angiography (CTA) revealed a ruptured aneurysm of the left A1-A2 junction. The aneurysm spontaneously thrombosed within 12 hours of presentation. Subsequent hospital course was complicated by arterial vasospasm and ischemia, and development of diffuse dural sinus thrombosis. Because of the uncontrolled aneurysm, no anticoagulation therapy was administered. The patient stabilized and was discharged approximately 5 weeks after admission. eight weeks later, CTA demonstrated recanalization of the aneurysm, now supplied by the right anterior cerebral and anterior communicating arteries. Endovascular coil embolization of the aneurysm and parent artery was performed without complication. Imaging studies at this time demonstrated development of a right lateral sinus dural arteriovenous malformation (DAVM).

**IMAGING FINDINGS**
Initial noncontrast CT imaging demonstrated basal subarachnoid hemorrhage and a hematoma projecting into the left frontal lobe. CT angiography (CTA) revealed a bilobed aneurysm arising from the left A1-A2 junction with a large surrounding hematoma. Subsequent catheter angiography (CA) demonstrated complete thrombosis of the left anterior cerebral artery, to include the aneurysm. Initial MRA, CTA, and CA studies all demonstrated a normal appearance of the right transverse sinus, without evidence for dural sinus fistula. Subsequent CT studies during the ini-
tial hospitalization demonstrated thrombosis of the right transverse sinus which progressed to involve both transverse and sigmoid sinuses, the superior sagittal sinus, straight sinus, and internal cerebral veins. CT angiography performed 8 weeks after discharge demonstrated a recanalized bilobed aneurysm at the anterior communicating artery complex, and enlargement of the right middle meningeal and occipital arteries coursing toward the right transverse sinus. Both catheter angiography at the time of coil embolization and subsequent MRA demonstrated a DAVM to the previously thrombosed right transverse sinus with flow from the tentorial artery and enlarged right middle meningeal and occipital arteries, without pial venous drainage.

SUMMARY

Slow flow DAVM are encountered almost exclusively in older adults, and have long been postulated to result from recanalization of prior sinus thrombosis. Dural AVFs in children are almost always congenital high flow lesions. DAVM developing after recanalization of a thrombosed dural venous sinus in an infant without congenital coagulation disorders has not been reported previously. This case is especially unique in that the development of the DAVM is clearly documented on CA, CTA, and MRA studies.

KEY WORDS: Arteriovenous fistula, dural sinus thrombosis, pediatrics

Paper 449 Starting at 4:12 PM, Ending at 4:20 PM

Runaway Dural Arteriovenous Fistulas

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PURPOSE

To describe a group of patients with multiple difficult to treat progressive intracranial dural arteriovenous fistulas with associated intracranial venous hypertension and dural sinus enlargement.

MATERIALS & METHODS

Retrospective and prospective review of institutional neurovascular data base, medical records, and patient interviews.

RESULTS

Dural arteriovenous fistulas (DAVFs) are rare. Fortunately, there are effective endovascular occlusion procedures and surgical interventions for the treatment of these potentially dangerous vascular lesions. A few patients, however, present with multiple DAVFs that cannot be cured with standard interventions. These patients suffer progressive neurologic deterioration with enlargement of existing fistulas, formation of new fistulas, and development of high risk features associated with increased chance of intracranial hemorrhage. We present three patients with such runaway DAVFs, describe the progression of their disease, discuss the challenges associated with their management and propose possible mechanisms responsible for the evolution of their multiple, treatment-refractory lesions. None of these patients had identifiable genetic or behavioral risk factors for hypercoagulability. The first patient, a female first diagnosed at age 9, presented to our tertiary care hospital at age 13 with multiple intracranial dural fistulas. Despite multiple embolization procedures and a craniotomy, the patient continued to sprout de novo fistulas and developed worsening neuro-cognitive deficits in the setting of intracranial venous hypertension. She died at age 26 due to an intracranial hemorrhage. The second patient, also a young woman, was first diagnosed at 18 years and presented to our tertiary care hospital with an extensive skull-based vascular malformation and multiple cranial neuropathies. She too underwent several endovascular embolizations. Nevertheless her disease progressed as she developed multiple de novo fistulas and developed worsening neuro-cognitive deficits in the setting of intracranial venous hypertension. She died at age 26 due to an intracranial hemorrhage. The second patient, also a young woman, was first diagnosed at 18 years and presented to our tertiary care hospital with an extensive skull-based vascular malformation and multiple cranial neuropathies. She too underwent several endovascular embolizations. Nevertheless her disease progressed as she developed multiple de novo fistulas, hydrocephalus, intracranial hypertension, and a basal ganglia hemorrhage. Our third patient, an 11-year-old girl diagnosed at 9 months of age with a forehead angioma, first presented to our tertiary care hospital with a history of multiple, treatment refractory, high-risk fistulas. She too underwent numerous embolization and neurosurgical procedures and developed new fistulas over time, including an orbital fistula. As the orbit lies outside the cranium, we surmise that elevated intracranial venous pressure cannot be the sole contributor to fistula formation. This fistula burden in this patient stabilized between age 14 and 15 years as did her clinical condition; she remains under neurologic and radiographic surveillance.

CONCLUSION

A subset of female patients with multiple dural arteriovenous fistulas demonstrate progressive disease which is currently not curable and only marginally treatable. Although intratra-
nal venous hypertension contributes to progression of the disease and its symptoms, it cannot explain fully extracranial fistula formation.

**KEY WORDS:** Fistula, dural, DAVF

Paper 450 Starting at 4:20 PM, Ending at 4:28 PM

**Evaluation of Sonic Microcatheter in the Endovascular Treatment of Cerebral Arteriovenous Malformation**

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**PURPOSE**
Sonic is a new generation of microcatheter used in endovascular treatment of cerebral arteriovenous malformations. Considering the technical characteristic of this microcatheter (detachment of the stuck distal part), we evaluated prospectively the 65 first microcatheters used in our institution. The goal was to evaluate the performance of navigation, injection of the embolic agent and distal detachment.

**MATERIALS & METHODS**
Sixty-five Sonic microcatheters were used between October 2006 and July 2007 in 41 patients (between 18 months and 75 years of age) during the endovascular treatment of 57 cerebral arteriovenous malformations and eight cerebral dural arteriovenous fistulas. The Sonic microcatheter was the first choice in 62 cases and the second in three cases after failure of another microcatheter. A success of navigation was defined by a microcatheter location allowing the liquid agent injection.

**RESULTS**
The placement was successful in 59 cases with six failures. The Onyx was used in 45 cases and NBCA in 14 cases. A microcatheter was stuck after Onyx’s reflux beyond the third marker. In 58 cases the microcatheter was able to be removed with (n = 45) or without (n = 12) detachment of the distal part. Six technical complications without clinical complication were observed: occlusion of the microcatheter during Onyx’s injection (n = 2), rupture of the microcatheter between the two distal markers (n = 2), migration of Onyx’s drop during the withdrawal (n = 2). The presence of three markers allowed in every case to estimate with precision the length of reflux.

**CONCLUSION**
Sonic navigation was successful and safe; the detachment of the distal part has decreased the difficulties and risks of the catheter withdrawal. In our experience, the Sonic catheter allowed to widen the use of Onyx.

**KEY WORDS:** Sonic, cerebral AVM, Onyx

Paper 451 Starting at 4:28 PM, Ending at 4:36 PM

**Emergency Clot Removal Therapy by Aspiration and Extraction for Probable Acute Embolic Carotid Occlusion**

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**PURPOSE**
It is difficult to achieve successful recanalization of embolic total occlusion of the carotid artery (CA), as large amount of clots is embedded in the CA. The purpose of our retrospective study was to investigate the feasibility, safety, and effectiveness of clot removal therapy (CRT) by aspiration and extraction (CRTAE) in patients with probable embolic total occlusion of the carotid artery (CA).

**MATERIALS & METHODS**
Inclusion criteria for retrospective analysis were patients with (1) sudden onset of symptoms, (2) serious neurologic symptoms of NIHSS score more than 5, (3) onset-to-CRT time shorter than 6 hours, (4) no cerebral hemorrhage on CT scans or extensive high signal-intensity on MR diffusion-weighted images, (5) no visualization of the carotid artery on MR angiograms, and (6) decrease of cerebral blood flow displayed by MR perfusion-weighted images (PWI). Clot removal therapy by aspiration and extraction was performed with inserting a 9Fr balloon-guide catheter to the affected CA for temporary occlusion during procedures. Clots were aspirated simply with a 10-ml syringe through a balloon-guide catheter under proximal flow control. Unless clots were aspirated, they were extracted with a microsnare or a filter-type catheter, sometimes disrupted by a balloon catheter. When atheromatous occlusion was diagnosed during procedures, stenting was performed. Recanalization rate, complications and neurologic status were evaluated. Neurologic status was accessed by NIHSS on admission and on the 7th day after CRTAE.

**RESULTS**
Between 2004 and 2007, 19 patients underwent CRTAE for probable embolic carotid occlusion. Their median onset-to-CRT time was 2.75 hours. Their median NIHSS score was changed from 17 on admission to 7 on the 7th day (p = 0.15, Wilcoxon signed ranks test). Successful recanalization was achieved in 11 of 19 patients (57.8%), and their median NIHSS score was improved from 16 on admission to 4 on the 7th day (p<0.005, Wilcoxon signed ranks test). Particularly in three of the 11 patients, clots were removed by aspiration only and complete recanalization was achieved. In two of the 11 patients, stenting following CRTAE was performed. In eight patients without any recanalization, median NIHSS score was changed from 18.5 on admission to 26 on the 7th day (n.s., Wilcoxon signed ranks test), two of the eight patients died within 7 days after stroke onset. Neither procedural complications nor hemorrhagic transformation following CRTAE occurred.

**CONCLUSION**
Emergency CRT by aspiration and extraction may be feasible, safe and effective to recanalize probable embolic carotid occlusion, to improve neurologic status soon in acute ischemic stroke patients.

**KEY WORDS:** Clot removal, embolic stroke, carotid occlusion
**Paper 452 Starting at 4:36 PM, Ending at 4:44 PM**

**Low-Dose Intraarterial Urokinase and Aggressive Mechanical Clot Disruption for Acute Ischemic Stroke after Failure of Intravenous Thrombolysis**

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**PURPOSE**
The purpose of this study was to prospectively evaluate the safety and efficacy of low-dose intraarterial (IA) urokinase and aggressive mechanical clot disruption (AMCD) after failure of intravenous thrombolysis for acute ischemic stroke.

**MATERIALS & METHODS**
We prospectively enrolled 12 patients with acute ischemic stroke who initially received intravenous (IV) rtPA and subsequently treated with combination therapy with low-dose IA urokinase and AMCD. Time to treatment, urokinase dose, duration of the procedure, recanalization rates, and symptomatic hemorrhage were analyzed. Clinical outcome measures were assessed on admission, at discharge (NIHSS) and 3 months (modified Rankin scale, mRS) after treatment.

**RESULTS**
Median NIHSS score on admission was 17. Median time from symptom onset to IV rtPA was 120 minutes, and median time from symptom onset to IAT was 230 minutes. The median duration of IAT was 55 minutes. Median dose of urokinase was 300,000 U. The recanalization [thrombolysis in cerebral ischemia (TICI) grade 2 or 3] was achieved in all patients. No procedure-related complications were observed. There was no symptomatic hemorrhage. At discharge, median NIHSS score was 3. The 3-month outcome was excellent (mRS 0, 1) in eight patients, good (mRS 2) in one patient, and poor (mRS 3-5) in three patients. There was no hospital or 3-month mortality.

**CONCLUSION**
Combination therapy with low-dose IA urokinase and AMCD in acute stroke patients after failure of IV thrombolysis was safe and effective. A high rate of recanalization, low rate of symptomatic hemorrhage, and excellent functional outcome can be achieved.

**KEY WORDS:** Acute stroke, thrombolysis, thrombolytic therapy

**Paper 453 Starting at 4:44 PM, Ending at 5:02 PM**

**Management of Tongue Venous Malformation**

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**PURPOSE**
To determine the efficacy of ethanol embolization in management of tongue vascular malformations.

**Materials & Methods**
Thirty-nine patients (22 females, 17 males; mean age: 38 years) presented to my service with tongue vascular malformations. Forty-seven patients had undergone 61 failed previous procedures (embo, laser, surgery, steroid injection, alpha-interferon, radiation). All patients had baseline angiograms and MRs. All patients underwent transcath and/or direct puncture ethanol therapy.

**RESULTS**
Of 39 patients with venous-lymphatic malformations, 18 patients had dramatic reduction and 21 patients’ therapy ongoing with concurrent reductions (mean f/up: 60 months). One patient with AVM required additional surgery and one patient with mixed veno-lymphatic malformation required surgical debulking of excess tissues. Minor complications such as tongue blisters (9 instances) healed spontaneously; three tongue injuries healed spontaneously; three infections responded to antibiotic treatment; one focal numbness resolved.

**Conclusion**
Ethanol embolotherapy is a primary form of therapy to eradicate high-flow and low-flow vascular malformations of the tongue permanently at long-term follow up. Rarely is concurrent surgery required.

**Key Words:** Vascular malformation

**Paper 454 Starting at 5:02 PM, Ending at 5:10 pm**

**Imaging Follow-Up of Endovascularly Treated Aneurysms: Who, How and When**

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**Presentation Summary**
Although cerebral aneurysms are being treated by endovascular means with increasing frequency, there are no clear guidelines as to how to follow these lesions over the long term. Review of the currently available literature lends some direction in the frequency of study and imaging modalities utilized to monitor treatment. This presentation will outline the short and long term imaging strategies developed through evaluation of data from large longitudinal series. A summary of these recommendations includes: 1) endovascularly treated (EVT) ruptured aneurysms should be followed early and for a long period; 2) the timing and type of follow-up depends upon the final images immediately post treatment; and 3) EVT unruptured aneurysms should have at least one follow up study in the first year; 4) MRA may have some advantage over DSA in the evaluation of internal cavities within the coil ball; and 5) stent-assisted aneurysms may require DSA for repeat study due to the artifact created on MRA.
Repeat Percutaneous Vertebroplasty in the Previously Treated Vertebral Levels with Fluid Sign and Recurrent Pain

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PURPOSE
The purpose of this study was to evaluate the therapeutic effect of repeat PV for recurrent pain resulting from treated vertebral levels with fluid reaccumulation. The clinical outcome of repeat PV was correlated with the follow-up MRI findings.

MATERIALS & METHODS
Repeat PV was performed in six patients in whom the follow-up MRI showed signs of fluid at the previously treated levels. We recorded the pain scores and mobility scores before the first PV, prior to the second PV, and 1 and 3 months after the repeat PV. MR imaging studies before the first PV, prior to the second PV, and 1 and 3 months after the repeat PV were performed.

RESULTS
Three females and three males with a mean age of 77 years were enrolled in this study. One month after the second PV, the six patients had a mean pain score reduction of 6.2 points and a mean postoperative pain level of 2.8 points. Four of the six patients demonstrated an improvement in mobility with a 1.7 point mean decrease 1 month after the second PV. There was decreased fluid and bone marrow edema in four of the six patients on the follow-up MRI 1 and 3 months after the second PV. Persistent signs of fluid were demonstrated in the other two patients on the follow-up MRI 1 and 3 months after the second PV.

CONCLUSION
Fluid reaccumulation in the treated vertebral bodies after PV may be a sign of subsequent failure to provide internal stabilization for healing, not a complication after PV. Repeat PV in the previously treated vertebral levels with fluid may offer therapeutic benefit for recurrent pain. The follow-up MRI after repeat PV may show decreased bone marrow edema and fluid in some patients, or persistent fluid in the bodies with minimal residual bone.

KEY WORDS: Vertebroplasty, recurrent pain, fluid sign

Adjacent Vertebral Fracture Is No More a Problem of Percutaneous Vertebroplasty

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PURPOSE
According to previous studies, new fracture in adjacent vertebral body fracture remained a problem after percutaneous vertebroplasty. We do preventive vertebroplasty to reduce the problem of adjacent vertebral body fracture, and we compared the occurrence of new fractures that occurred after vertebroplasty in cases with preventive vertebroplasty and in cases with no preventive vertebroplasty.

MATERIALS & METHODS
In preventive vertebroplasty, we injected bone cement into the proximal part of the adjacent vertebral body and let the distal part of the vertebral body uncemented. Also, we avoid dense packing of bone cement when we do preventive vertebroplasty. Totally we have 163 patient who received follow up for more than 1 year, including 80 cases without preventive vertebroplasty (length of follow up 843 ± 413 days) and 83 cases with preventive percutaneous vertebroplasty (length of follow up 502 ± 196 days).

RESULTS
In the group with no preventive vertebroplasty, 50% had new fracture after vertebroplasty: 29% had adjacent fracture only, 18% had both adjacent and nonadjacent fracture, 2.5% had nonadjacent fracture only. In the group with preventive percutaneous vertebroplasty, 13% had new fracture after percutaneous vertebroplasty (length of follow up 843 ± 413 days) and 83 cases with preventive percutaneous vertebroplasty (length of follow up 502 ± 196 days).

CONCLUSION
New fractures, especially new adjacent fractures are not a problem in our patients who received percutaneous vertebroplasty because of the adoption of preventive vertebroplasty.

KEY WORDS: Percutaneous vertebroplasty, fracture, spine, osteoporosis
Retrospective Comparison of Pain Relief and Complication Rate with Vertebroplasty and Kyphoplasty in Patients with Vertebral Body Compression Fractures: Single-Center Experience

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Indiana University
Indianapolis, IN

PURPOSE
Percutaneous vertebral augmentation to treat pain associated with vertebral compression fractures is growing in popularity. Transpedicular vertebroplasty, and more recently, kyphoplasty are the main techniques, but little has been published comparing their safety and efficacy.

MATERIALS & METHODS
From June 2006 to November 2007, we identified all patients in our medical center with osteoporotic vertebral body compression fractures that underwent vertebroplasty or kyphoplasty for pain relief. We documented age, gender, indication for the procedure, procedure hospital, number of vertebral levels treated, complications, and pain relief 2 weeks postprocedure and at last follow-up visit.

RESULTS
Twenty patients (15 male) with 33 fractures were identified, with age 50-59 years (n = 3), 60-69 years (n = 5), 70-79 years (n = 9), and 80-89 years (n = 3). Ten underwent intervention at a tertiary care hospital, and 10 at a veterans hospital. Ten patients (21 of 33 fractures, 64%) were treated with vertebroplasty, and 10 (12 fractures, 36%) with kyphoplasty. Thirteen of 20 patients (65%) had one single-level treatment, and seven patients (35%) had treatment in multiple levels (maximum six levels). No more than two levels were treated at one time. Nine of 10 vertebroplasty and 9 of 10 kyphoplasty patients reported significant pain relief 2 weeks postprocedure, and nine vertebroplasty and 10 kyphoplasty patients had significant relief at last follow up (mean 7 months, range 1-16 months). One vertebroplasty patient had no pain relief. One minor complication (hypotension and bradycardia in a vertebroplasty patient) was observed, which resolved with intravenous fluids and atropine.

CONCLUSION
Percutaneous vertebral augmentation with either vertebroplasty or kyphoplasty is a safe and effective treatment for vertebral compression fractures refractory to medical treatment.

KEY WORDS: Vertebroplasty, kyphoplasty, augmentation
References


Key Words: Kyphoplasty, spinal injuries, quality of life

Paper 459 Starting at 4:02 PM, Ending at 4:10 PM

Kyphoplasty in Osteoporotic, Neoplastic and Traumatic Vertebral Body Fractures: Early Mobilization and Pain Relief

De Simone, A. · Nina, P. · Alvino, V. · Franco, A. · Delehaye, L. · Apolito, R.
Ospedale Napoli, ITALY

Purpose

Percutaneous vertebral augmentation is gaining growing acceptance and is becoming the standard of care for pain associated with compression fractures of the spine. In addition, both vertebroplasty and kyphoplasty allow early mobilization after injury. At our institution, kyphoplasty is customarily performed and our results are reported here. In keeping with data recently published by Greene and coworkers, we feel that the inflatable balloon tamp is an useful aid when cortical bone is violated. This is the main reason why we prefer kyphoplasty. In such cases, preliminary coverage of osseous defects is obtained, as far as possible, by repeat injections of small amounts of dough-like cement before filling up the bone cavity.

Materials & Methods

From June 2005 to October 2007, 33 hospitalized patients (age: 18-92 years; M: 19, F: 14) underwent kyphoplasty because of vertebral body fractures, involving the spine from T5 through L5. Specifically, 25 were traumatic injuries (Magerl Type A) and eight were spontaneous, pathologic fractures. In 11 cases, retropulsion of fracture fragments caused effacement of the epidural space. No patient presented radicular signs. Preoperatively, a CT scan was performed and radiographs obtained to assess vertebral deformity, while clinical data were supplemented by Visual Analog Scale (VAS) pain rating. All of the above were repeated after kyphoplasty. Follow-up evaluations were scheduled at 1, 3, 6, 12 and 24 months.

Results

Early mobilization (on the second postop day) was obtained in all patients, as well as pain relief (baseline VAS score: 8.1 95% CI 7.7-8.5; 48-hr post-op: 1.4 95% CI 0.9-1.9). Radiographic improvement was only slight or moderate. In nine subjects, limited amounts of cement leakage were detected. No clinical complications occurred.

Conclusion

Osteoporotic and neoplastic fractures are main indications to both vertebroplasty and kyphoplasty. Furthermore, it has been suggested recently that kyphoplasty can be a safe and effective treatment also in appropriate patients with traumatic injuries, provided that there is a lower destruction level of the vertebral body. Cortical bone violation and retropulsion of bone fragments add to technical difficulties and pose additional problems, but they also can be faced by experienced interventionalists who feel comfortable in dealing with such challenging cases. Moreover, careful injection technique, in a cavity previously remodelled by an inflatable balloon tamp, can be a valuable help. Our data are in keeping with those previously reported that percutaneous vertebral augmentation can produce immediate improvement in a patient’s quality of life. They also support feasibility and safety of kyphoplasty as a less invasive technique to stabilize the spine after osteoporotic, neoplastic and even traumatic fractures.

References


Key Words: Kyphoplasty, spinal fractures, quality of life

Paper 460 Starting at 4:10 PM, Ending at 4:18 PM

Clinical Significance of Schmorl’s Nodes in Percutaneous Vertebroplasty

Fuwa, S. · Ishiyama, M. · Numaguchi, Y. · Kobayashi, N. · Uemura, A. · Saida, Y.
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Purpose

Schmorl’s node (SN) often accompanies compression fracture of the vertebral bodies. The purpose of the study is to investigate the imaging characteristics and clinical significance of SN in percutaneous vertebroplasty.

Materials & Methods

We retrospectively reviewed the imaging findings of SN in the vertebra of 100 patients who underwent percutaneous vertebroplasty for osteoporotic compression fracture. Preoperative CT (3D MPR) and MR were reviewed with special interest in the prevalence, location, configuration, signal characteristics and contrast enhancement patterns of SN. The relationship of SN to coexisting intravertebral cleft and cement distribution patterns in and around SN also were investigated using pre and postoperative CT.

Results

Percutaneous vertebroplasty was performed for 181 vertebrae in 100 patients. Of the 181 vertebrae, a total of 85 SNs were noted in 82 vertebrae. The majority of the SN was...
small in size and located in the superior end plate of the vertebra. A total of 37 SNs (43.5%) were accompanied with severely fractured vertebrae which were often large in size and associated with an intravertebral cleft. Differentiation between the cleft and SN in such cases was sometimes difficult but was possible by thorough analysis of the cortical margin on CT and signal characteristics of the cleft and SN on MR prior to vertebroplasty. In 70 of 85 SNs (82.4%), cement did not enter into the SN during vertebroplasty even though the needle passed through the SN. In the other 15 (17.6%), cement inflow into the SN was observed. Notably, in 6 SNs, gas was noted in the SN as well as in the cleft. In 5 of them, cement inflow into the SN occurred. There was no direct correlation between cement inflow into the SN and various imaging findings including marginal sclerosis on CT, and contrast enhancement in the SN on MR.

**CONCLUSION**

Coexistence of a large SN and intravertebral cleft is common in markedly fractured vertebrae. Cement inflow into SN infrequently occurs during vertebroplasty.

**KEY WORDS:** Percutaneous vertebroplasty, Schmorl’s node

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**Paper 461 Starting at 4:18 PM, Ending at 4:26 PM**

**Percutaneous Vertebroplasty for Painful Schmorl’s Node without Abnormal Signal in the Vertebral Body**

Fuwa, S. · Ishiyama, M. · Numaguchi, Y. · Kobayashi, N. · Uemura, A. · Saída, Y.

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Tokyo, JAPAN

**PURPOSE**

It is not uncommon to have a Schmorl’s node (SN) in painful osteoporotic compression fractures of the vertebral bodies. The MRI in such cases usually shows abnormal signal in the vertebral body including bone edema or the presence of a cleft. Among our 530 patients who underwent percutaneous vertebroplasty (PV), we treated a group of patients with back pain and disability whose MRI showed a large SN but no abnormal signal in the vertebral body itself. We analyzed their imaging findings and evaluated the effectiveness of PV in these patients.

**MATERIALS & METHODS**

This retrospective analysis includes 10 patients (8 females and 2 male) whose ages ranged from 62 to 80 years. Their MR findings were evaluated in terms of degree of compression fracture of the vertebral body, and the location, signal intensity and extent of contrast enhancement of SN. The clinical assessment was made with visual analog score (VAS; max. 10) and modified Roland Morris ADL score (max.20) before and after PV.

**RESULTS**

Compression fracture of the vertebral body was mild to moderate in eight and severe in two. A total of 14 SNs were seen in 10 patients including two patients having multiple SNs. The SNs were located in the superior end plate in most patients, but in one, SN was seen in the inferior end plate and another patient had both superior and inferior end plate. On T2-weighted imaging, they showed hyperintensity in 13 and isointensity in one. There was moderate to marked contrast enhancement in all 14 SNs. The size of SNs was small or medium in three and large in 11. After PV, eight patients demonstrated marked clinical improvement with VAS from 6.9 to 1.0 (average 5.9) and ADL score from 13.8 to 3.8 (average 8.8). In two patients, PV was not effective including one patient who had severe compression fracture with a large SN and another patient with moderate compression fracture with the SNs in the superior and inferior end plate.

**CONCLUSION**

Although our case number is limited, the SNs with contrast enhancement and hyperintensity on T2-weighted imaging in the fractured vertebral body may cause symptoms. PV may be an effective treatment for these patients.

**KEY WORDS:** Percutaneous vertebroplasty, Schmorl’s node

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**Paper 462 Starting at 4:26 PM, Ending at 4:34 PM**

**Percutaneous Cryoablation and Vertebroplasty Therapy in Metastatic Spinal Involvement**

Masala, S. · Massari, F. · Manenti, G. · Mammucari, M. · Bartolucci, D. A. · Simonetti, G.

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Rome, ITALY

**PURPOSE**

The spinal column is the most common location among osseous sites for metastatic deposits. Typically thoracic spine is the most frequent site of disease (70%), followed by lumbar (20%) and cervical spine (10%). Approximately 50% of metastases arise from one of these primary types of cancer: breast, lung, prostate or melanoma. These commonly cause spinal metastases in 74.3%, 44.9%, 90.5% and 54.5% of patients, respectively. Aim of this study is to determine the safety and effectiveness of cryoablation and vertebroplasty therapy (CVT) in pain reduction and daily life activities improvement in patients with spinal painful metastatic lesions.

**MATERIALS & METHODS**

During a period between October 2005 and September 2007, we treated with CVT, 15 patients (9 men, 6 women; mean age 54 years) with at least three vertebral painful metastatic lesions, with positive Visual Analogue Scale (mean score: 8.1). These terminally ill patients were neither candidate for resective surgery nor responding to conventional radiation treatment or chemotherapy. Cryoablation was performed using two 17 Gauge cryoprobes, coaxially introduced through bone biopsy needles previously inserted into vertebral body. After cryoablation, percutaneous injection of polymethylmethacrylate (PMMA) was performed.

**RESULTS**

Postprocedural evaluation confirmed reduction of the VAS (mean score: 3.8). There was a marked increased in activities of daily living and reduction in narcotics utilization. No serious complications were observed in our study.

**CONCLUSION**

In our experience CVT demonstrated to be an easy, effective and feasible technique. This minimally invasive procedure is
ideal for treatment of patients with painful bone metastases. Where standard treatments have failed, combined cryoablation and vertebroplasty treatment is characterized by immediate pain relief, with only minor complications noted.

**KEY WORDS:** Spine, vertebroplasty, cryoablation

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**Paper 463 Starting at 4:34 PM, Ending at 4:42 PM**

**MR Appearance of Osteoporotic Compression Fractures: Correlation with Subsequent Cement Distribution in Vertebroplasty**

Short, J. H. · Maya, M. · Moser, F. G. · Pressman, B. D.

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Los Angeles, CA

**PURPOSE**
This study was intended to identify specific MR findings in osteoporotic compression fractures which can be correlated with cement distribution in vertebroplasty, which may be used to guide operative technique.

**MATERIALS & METHODS**
Vertebroplasty procedures performed for osteoporotic fractures over the past 3 years were reviewed retrospectively on patients whose preoperative MRI examinations were available. The preoperative MRI examinations were evaluated for appearance of the fracture (edema pattern, height loss, fracture position). Postprocedure radiographs were evaluated for pattern of cement distribution.

**RESULTS**
Vertebroplasty was performed on 142 vertebral bodies. Seventy-six of these (54%) had minimal (<25%) loss of height, 60 (42%) had moderate (25-75%) loss of height and 6 (4%) had severe (>75%) loss of height. An intravertebral cleft was seen in 37 (26%). In 102 (72%) of vertebral bodies, edema occurred in a discrete band. In the other 40 (28%) a diffuse pattern of edema was seen. In vertebral bodies with a discrete pattern, the edema was localized to the superior portion in 73 (72%), the inferior portion in 19 (19%) and the central portion in 10 (10%). In 42 (41%) of the 102 bodies, cement was largely confined to the pattern of the edema. The other 60 (59%) showed a diffuse pattern of cement distribution. Of these 26 (43%) had all or almost all cement deposited separate from the location of edema seen on MRI. In most of these, edema was located in the superior aspect of the vertebral body and cement was deposited at the inferior and central aspect of the body. In the 40 vertebral bodies with the diffuse edema pattern, postprocedure radiographs showed a diffuse cement distribution in 26 (65%) and a band-like distribution in 14 (35%). Of the 37 bodies with an intravertebral cleft, 24 (65%) had cement deposited largely within the cleft, while 13 (35%) had a diffuse pattern of cement distribution.

**CONCLUSION**
A linear cement collection on postprocedure films is consistent with cement distribution within fracture or cleft, while a more diffuse pattern suggests deposition within trabecular bone. The pattern of edema on preprocedure MRI correlates with cement distribution. We propose that analysis of the preprocedure edema pattern be used to guide needle placement. Further analysis of patient outcomes will be presented.

**KEY WORDS:** Vertebroplasty, osteoporosis, MRI

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**Paper 464 Starting at 4:42 PM, Ending at 4:50 PM**

**Sacroplasty Using a Side Hole Injection Device**

Georgy, B. A.¹²

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**PURPOSE**
Routine sacroplasty can be associated with leakage of cement into the sacral neural foramina. The purpose of this study is to evaluate the safety and clinical feasibility of performing sacroplasty using a bone filler device with a side hole to direct the cement away from such vital structures.

**MATERIALS & METHODS**
Retrospective evaluation of CT examination performed immediately after successful 14 sacroplasty procedures in 11 patients (9 women and 2 men) were reviewed after appropriate institutional approval. Eight cases were due to benign insufficiency fractures and three cases due to malignant metastasis. Nine cases were done under fluoroscopy guidance while two cases were performed using CT guidance. All cases were performed using a KyphX directional bone filler device (Kyphon Inc., Sunnyvale, CA) with a single distal
end side hole. An average 2-3 cc of bone cement was inject-
ed in each side. Cement was injected with the side hole
directed towards the desired directions for cement deposi-
tion, usually away from the neural foramina. Pain relief was
evaluated using visual analog scale before and within 2-4
weeks after the procedure during follow up.

RESULTS
Cement was deposited along or nearby the fracture line in all
cases. No cement leakage was noted in the sacral neural
foramina. Two cases showed minimal cement in the nearby
S1 joint and were not significant. In one malignant case min-
imal leakage along the anterior wall of S2 was noted. Eight
patients reported pain relief, while two patients had no pain
relief. One patient was lost in follow up.

CONCLUSION
Injection devices with side hole rather than end hole may
provide more directional control of the cement during injec-
tion. This technique may be used to redirect the cement away
from critical structures and can be particularly useful in per-
forming sacroplasty under fluoroscopy guidance.

KEY WORDS: Sacroplasty

Paper 465 Starting at 4:50 PM, Ending at 4:58 PM
MDCT vs DynaCT: Usefulness for Percutaneous
Vertebroplasty

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PURPOSE
To evaluate usefulness of MDCT and DynaCT for percuta-
aneous vertebroplasty.

MATERIALS & METHODS
This study included 19 patients (12 females and 7 males)
with osteoporotic compression fractures (45 vertebrae).
MDCT and DynaCT were obtained before and after proce-
dure. Multiplanar reformation with axial, sagittal and coro-
nal sections was obtained. Presence of cortical defect, vacu-
um phenomena in adjacent disks and cement leakage was
evaluated.

RESULTS
All 60 cortical defects seen on MDCT also were observed on
DynaCT. Vacuum phenomena were seen in 38 disk spaces on
MDCT. They were detected on DynaCT in 34 (sensitivity of
84%, specificity of 96% and accuracy of 91%). Cement leak-
age was noted at 16 disk spaces (36%), 12 paravertebral soft
tissues (27%) and 11 paravertebral veins (24%) without dif-
fERENCE in these two modalities.

CONCLUSION
DynaCT is feasible to evaluate vertebral fractures and
cement distribution during vertebroplasty.

KEY WORDS: Vertebroplasty, computed tomography,
DynaCT

Thursday Afternoon
5:00 PM – 5:15 PM
La Louisiane Ballroom

(60) Closing Remarks

– Robert D. Zimmerman, MD, FACR, ASNR President
Scientific Posters 1 – 212

Exhibit Hall B1

Monday, June 2
12:00 PM – 9:00 PM

Tuesday, June 3 – Wednesday, June 4
6:30 AM - 9:00 PM

Thursday, June 5
6:30 AM – 3:00 PM

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

Scientific Poster 1

Assessment of Thrombus on Noncontrast CT in Acute Ischemic Stroke: Value of Thin-Section Images Reconstructed from Combined Images of Thinly Collimated Multidetector-Row CT

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Purpose
Rapid assessment of the presence and extent of thrombus on CT in acute ischemic stroke may be helpful in determining treatment modality. We hypothesized that 1.25 mm images reconstructed from 5 mm multidetector-row NCT images (4 × 1.25 mm) could be better in evaluation of presence and extent of thrombus than 5 mm NCT images alone. The purpose of this study was to investigate whether the thin-section images reconstructed from 5 mm multidetector-row noncontrast CT (NCT) images may improve assessment of the presence and extent of acute thrombus.

Materials & Methods
We enrolled 73 patients with acute MCA territorial infarction who underwent both 5 mm NCT (collimation, 4×1.25 mm) and CT angiography (CTA) within 6 hours of symptom onset. Four 1.25 mm images were reconstructed from each 5 mm NCT image (Fig A). Two neuroradiologists independently determined the presence and extent (ICA, M1, and M2 segment) of thrombus on both 5 mm and 1.25 mm NCT at two separate sessions. Occlusion was determined by CTA. In regard to detection and extent of thrombus, inter-rater agreement and McNemar test were performed for 5 mm and 1.25 mm NCT, respectively.

Results
Inter-rater agreement for detection and extent at 5 mm and 1.25 mm NCT were all excellent [κ = 0.88 and 0.94, respectively (detection); weighted κ = 0.90 and 0.97, respectively (extent)]. In regard to the presence of thrombus, sensitivity, specificity, and accuracy were 54.3%, 100% and 71.2% at 5 mm NCT, and 93.5%, 100% and 95.9% at 1.25 mm NCT, respectively (p < .001) (Fig B). In regard to the extent of thrombus, those were 55.1%, 100% and 85.8% at 5 mm NCT, and 95.7%, 100% and 98.6% at 1.25 mm NCT, respectively (p < .001).

Conclusion
The presence and extent of acute thrombus can be determined with higher sensitivity by thin-section reconstructed images than by 5 mm NCT.

Key Words: Acute ischemic stroke, CT, thrombus
Poster 2
Detection of Luxury Perfusion via Utilization of Time-To-Peak, Delay, Transit Time, and Blood Volume Maps in Patients Initially Suspected to Have Acute Infarction

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Minneapolis, MN

PURPOSE
This preliminary study addresses the hyperperfusion phenomenon in cerebral infarcts on CT perfusion (CTP) that occasionally may mask subacute (and rarely) acute infarcts. We evaluate the use of time to peak (TTP), Delay, cerebral blood volume (CBV), and mean transit time (MTT) maps via dynamic CTP in detecting these infarcts.

MATERIALS & METHODS
We retrospectively reviewed the neuroradiology imaging data base from 2005-2007 for CTP exams performed in patients who presented with stroke or stroke-like symptoms. Of the 370 examinations, there were 10 patients in which the CBV and CBF were not visually decreased, with clearly hypodense infarct on CT or restricted diffusion on MRI > 2 cm size (so it could be measurable on CTP). Internal review board approval was obtained. Using CTP software (VITREA, Minnetonka, MN), MTT, TTP, Delay, CBF and CBV were calculated in areas of infarction and (via an “automirror” function) in the contralateral, unaffected hemisphere. The region of interest was drawn in the affected area seen on CT or diffusion MRI. Two neuroradiologists reviewed these CTP maps in consensus. Means were obtained for each parameter; a paired student t-test was applied.

RESULTS
The mean time to presentation was 7.7 days (18 hours-10 days) after symptom onset. Two patients presented in the acute (but not hyperacute) phase of stroke (18 and 24 hours). There were five males and five females (mean age 58.7 years). Infarcts were in the following distributions: MCA (5), ACA (3), PCA (1) and PICA (1). The difference between the mean values of TTP, MTT, and CBV on the affected versus the contralateral hemisphere was statistically significant at 95% confidence interval (p=0.005, 0.027, 0.03, respectively). Difference in the mean Delay was probably significant (p=0.077), but not at the 95% confidence interval. The difference between the mean values of CBF was not statistically significant (p=0.76). The TTP, MTT, CBV, and Delay values increased by a mean of 10%, 38.1%, 26.7% and 57.9%, respectively.

CONCLUSION
A combination of the TTP, MTT, and Delay maps may aid in detecting luxury perfusion, where the CBF may be within normal limits and the CBV may appear to be mildly elevated in patients who have already suffered irreversible cerebral infarction. This is presumed related to early contrast enhancement of infarcted tissue. We note that this typically occurs in the subacute phase, but may occasionally occur acutely (age < 3 days), presumably related to blood-brain barrier breakdown.

KEY WORDS: CT perfusion, luxury perfusion, infarction

Poster 3
Visualization of Hemodynamic Information of the Circle of Willis Using Three-Dimensional MR Digital Subtraction Angiography without Contrast Material

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1Toho University, Tokyo, JAPAN, 2Toshiba Medical Systems, Tokyo, JAPAN, 3Toshiba Medical Systems, Tochigi, JAPAN

PURPOSE
Time of flight (TOF) MR angiography (MRA), a vast majority method for anatomical information of the intracranial arteries, usually has provided no hemodynamic information. Instead of TOF MRA, contrast-enhanced MRAs had been used in evaluation of hemodynamic information. Recently, dynamic MRA based on arterial spin labeling (ADL) is introduced as a novel MRA technique providing blood flow patterns without contrast material (1). This study examines the feasibility of a new MRA technique, three-dimensional (3D) magnetic resonance digital subtraction angiography (MRDSA) without contrast material, which is essentially 3D true steady-state free precession (SSFP) with selected inversion recovery (IR) pulse using multiple cardiac phase acquisitions with a short increment delay for clinical use at 1.5 T.
Three-dimensional TOF MRA and serial MRA images using 3D MRDSA without contrast material were acquired from 10 healthy volunteers and three arterial steno-occlusive disease patients in axial plane, covering the circle of Willis. All imaging time of 3D MRDSA was up to approximately 15 minutes because multiple data acquisition with varied delay time after IR pulse was needed. The labeling slab covered unilateral internal carotid artery (ICA) for MR imaging of blood supply from each ipsilateral side. Two neuroradiologists evaluated visualization of blood flow patterns from each ICA to the circle of Willis visually on 3D MRDSA on a workstation.

RESULTS
Compared with 3D TOF MRA, 3D MRDSA without contrast material clearly visualized the circle of Willis. In all volunteers, 3D MRDSA containing hemodynamic information from each ICA were imaged successfully. In patients with arterial steno-occlusive disease, arrival delay of blood flow in the affected side and collateral blood flow via the circle of Willis were demonstrated on 3D MRDSA.

CONCLUSION
In summary, 3D MRDSA without contrast material provides hemodynamic information of the circle of Willis, and it may play an important role in assessing cranial arteries in clinical use.

REFERENCES

KEY WORDS: Circle of Willis, MRDSA, hemodynamic information

Poster 4
Withdrawn

Poster 5
Outcome in Acute Strokes with Carotid Occlusion Treated with Angioplasty/Stenting and Thrombolysis

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1Saint Luke’s Brain and Stroke Institute, Kansas City, MO,
2University of Missouri-Kansas City, Kansas City, MO

PURPOSE
This retrospective study was conducted in an attempt to statistically evaluate the risks and benefits associated with stroke intervention in patients with carotid occlusion.

MATERIALS & METHODS
From February 2000 to date, 60 patients presented with acute stroke and carotid occlusion. Fifty-four underwent intervention including Merci retriever with and/or without TPA within 8 hours of onset. Six cases have low NIH Stroke Scale (NIHSS) attributed to collateral flow. In the 54 treated, there were 34 males and 20 females aged 40 to 94 years. There were five carotid dissections and one left common carotid occlusion. Postintervention noncontrast CT heads were done to diagnose secondary hemorrhages.

RESULTS
Admission NIHSS range was 2 to 37 (mean 18). Mortality = 27.7% (15/54). NIHSS improved by ≥ 9 occurred in 30% (16/54). Intracranial occlusions: Middle cerebral artery (MCA) = 52; anterior cerebral artery (ACA) = 11; posterior cerebral artery (PCA) = 2; MCA and ACA = 10. Revascularization was accomplished in all patients; 52 with angioplasty + stent, 2 with angioplasty. Adjunctive therapy is summarized in Fig 1. Following intervention, 72% of patients (39/54) had a mean TIMI score of IIb. Of the 39, 85% of the recanalization attempts in this group resulted in complete or partial perfusion of the artery ≥ 50% of its main branches (TIMI IIb-3). In the mortality group, only 38% (5/15) had a TIMI score of IIb. The mean time from symptom onset to intervention in 35/39 was 3.6 hours (range 2-6.5 hours). The mortality group was 6.5 hours (range 4 hours 15 minutes to 8 hours). ECASS I classification was used for hemorrhages. PH-2 classification, associated with significant effect on morbidity and mortality, was seen in 7/23 (30%) hemorrhages. In five of the seven patients, the stroke onset time to intervention was either unknown or ≥ 6 hours. Asymptomatic contrast staining was seen in 8/54 patients (19%). Pericallosal artery perforation occurred intraoperatively in one patient.

CONCLUSION
Revascularization of acute carotid occlusions in the stroke setting is technically feasible and potentially of great benefit, yet it still carries moderate morbidity and mortality.

KEY WORDS: Carotid occlusion

Poster 6
Hyopoperfusion and Ischemia in Cerebral Amyloid Angiopathy Documented by Tc-99m-ECD Brain Perfusion SPECT

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Seoul, REPUBLIC OF KOREA

PURPOSE
Cerebral amyloid angiopathy (CAA) is known as an important cause of spontaneous cortical-subcortical intracranial hemorrhage in normotensive elderly. However, the patients with CAA can manifest leukoencephalopathy, brain atrophy, and ischemia also. Hypoperfusion resulting from vessel wall deposition of beta-amyloid may be responsible for these
We would like to verify the pathologic effect of CAA on cerebral hypoperfusion and ischemia by using Tc-99m-ECD brain perfusion SPECT.

**Materials & Methods**

Total eleven patients (M: 5, F: 6, age range: 48-75 years (65.0 ± 13.3)) with clinically and radiologically proved probable CAA (more than 15 petechial hemorrhagic or hemosiderin deposition foci on the brain MRI) and have undergone Tc-99m-ECD SPECT together are included in our study as a patient group. Tc-99m-ECD SPECT scans also were obtained in 13 age-matched healthy control subjects (M: 7, F: 6, age range: 60-79 years (66.7 ± 6.4)) for comparison. Relative rCBF in patients and normal controls were compared using SPM2.

**Results**

In comparison with normal controls, the hypoperfusion areas are as follows: inferior parietal lobule of both parietal lobes (BA 40), middle temporal gyrus of left temporal lobe (BA 39), postcentral gyrus of right parietal lobe, superior temporal gyrus of right temporal lobe (BA 22), superior temporal gyrus of right frontal lobe (BA 10), inferior temporal gyrus of left temporal lobe (BA 20), both caudate bodies.

**Conclusion**

Cerebral perfusion was decreased significantly in patients with diffuse petechial CAA. These findings are very informative to predict the risk of the cerebral hypoperfusion in patients with CAA resulting in leukoencephalopathy, atrophy, and ischemia.

**Key Words:** Amyloid, angiopathy

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**Poster 7**

**Diffusion-Weighted MR Imaging in Evaluation of Cerebral Ischemic Clinically Silent Lesions after Diagnostic Coronary Angiography**

Restaino, G. · Missere, M. · Cucci, E. · Pierro, A. · Ciuffreda, M. · Sallustio, G.

Catholic University of Sacred Heart Campobasso, ITALY.

**Purpose**

Previous studies reported that silent ischemic stroke occurs in 11-15% of patients as a complication after diagnostic and/or therapeutic coronary angiography. The aim of our prospective study was to assess the incidence of silent stroke in patients after purely diagnostic coronary angiography with MR DWI images and corresponding apparent diffusion coefficient (ADC) maps.

**Materials & Methods**

Twenty patients (16 males and 4 females, median age: 63.3 years) were imaged on a 1.5 T MR scanner using 8-channel neurovascular coil 24-48 hours prior and 24-48 hours after coronary angiography. Axial FRFSE T2-W, T2-FLAIR and SE EPI DWI images were achieved. Imaging findings on structural MRIs and DWI were evaluated. On corresponding ADC maps, 8 ROI-measurements inside symmetrically located target-sites (white matter and basal ganglia) of brain were performed and the mean ADC value was analyzed with Wilcoxon rank sum test.

**Results**

No patient had neurologic symptoms or signs prior to or after coronary angiography. The evaluation of MR images pre and postcoronary angiography showed no new ischemic lesion as complication of this diagnostic procedure. No statistically significant difference between ADC values before and after coronary angiography was observed in the target-sites.

**Conclusion**

Although not statistically significant due to small patient sample, our results indicate that purely diagnostic coronary angiography is not associated to increased risk of clinically silent cerebral stroke, despite previously published data.

**Key Words:** Silent cerebral ischemia, diffusion-weighted imaging, diagnostic angiography
Poster 8
Autologous Stem Cell Transplantation Protects MS Patients against Brain Atrophy

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PURPOSE
Autologous stem cell transplantation (ASCT) has been considered an alternative therapeutic option for multiple sclerosis patients with an aggressive disease course refractory to conventional treatment. Here we aim to report the preliminary results comparing the parenchyma loss, over 1 year, between multiple sclerosis patients with and without ASCT. The non-ASCT group is composed of patients matched by age, disease duration and severity that would have indicated a transplant but the treatment option was refused.

MATERIALS & METHODS
The casuistic was composed of 14 individuals, where seven composed the ASCT group and seven the non-ASCT group. The binary region-of-interest maps of white matter (WM) gray matter (GM), and cerebrospinal fluid (CSF) were segmented automatically, allowing the calculation of the brain parenchyma fraction (BPF), obtained by \( \frac{[(WM+GM)/(WM+GM+CSF)]*100} \). Patients were compared by the rate of BPF reduction over a 1-year period. Stem cells were mobilized from the bone marrow to circulation after administration of 50 mg/Kg IV cyclophosphamide and granulocytic growth factor. At least 200,000,000 stem cells were collected by leucapheresis, cryopreserved and infused together with antitimocytic globulin, after the conditioning regimen (200 mg/Kg/IV cyclophosphamide).

RESULTS
The t-student’s test showed a significant difference between groups. When the values’ difference of BPF was compared it showed a significant difference (\( p = 0.0009 \)), where the loss mean of non-ASCT was 3.47% (± 1.33) and of ASCT was 1.07% (± 0.56). The graph shows the comparison between groups.

Conclusion
Our results show a reduction in the atrophy rate in patients submitted to ASCT, reinforcing the concept that this therapy has the potential to protect brain tissue damage and can be an alternative treatment for MS patients that do not respond to conventional therapy.

KEY WORDS: Multiple sclerosis, autologous stem cell transplantation, MRI

Poster 9
Voxel-Based Specific Regional Analysis System for Alzheimer Disease Statistics: Comparison with Visual Assessment to Evaluate Degree of Hippocampal Atrophy in MR Imaging of Cognitively Impaired Patients

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PURPOSE
Recently available software, voxel-based specific regional analysis system for Alzheimer disease (VSRAD), is one of the voxel-based morphometric analyses for MRI diagnoses of AD in Japan, which offer Z score as the statistical result from VSRAD to the clinician for an index of medial temporal region atrophy. The purpose of our study was to evaluate hippocampus atrophy with 4-point scoring system visually and compared the results with VSRAD to determine diagnostic availability of VSRAD.

MATERIALS & METHODS
Fifty patients (22 men, 28 women; age range, 55-85 years) with dementia were included in this study. Three-dimensional sagittal T1-weighted and coronal images from maximum intensity projection (MIP) were taken. Using the volume data from MR images, we calculated atrophy of parahippocampal gyrus as a Z score from VSRAD and evaluated the Z score with 4-point rating system [normal (4), mild (3), moderate (2), Severe (1)]. We visually assessed the atrophy of the hippocampus into 4 point with the same rating system. Kappa index (K) was calculated to determine interobserver agreement and Spearman’s rank correlation coefficient to investigate whether the degree of atrophy as evaluated by Z score was correlated with visual evaluation.

RESULTS
High correlation between both readers was found (0.92). Compared to suspected dementia, AD patients had increased Z score. There was a positive correlation between the degree of atrophy assessed by Z score and that found by visual evaluation (\( p = 0.769, \rho < 0.01 \)).

CONCLUSION
Our findings suggested that visual evaluation and VSRAD were consistent in AD group. Voxel-based specific regional analysis system for Alzheimer disease is diagnostically helpful to detect AD patients specifically. If the diagnostic value of VSRAD is established in patients with dementia, clinician will be relieved from diagnostic difficulties in patients with dementias in Japan and other countries.

KEY WORDS: VSRAD, Alzheimer disease, hippocampus
Apparent Diffusion Coefficient for Quantification of Low-Grade Hepatic Encephalopathy

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PURPOSE
Some cirrhotic patients with apparently normal mental status may be found to have abnormalities in cognitive function. This group of patients is considered to have minimal hepatic encephalopathy (HE). Recently, low-grade cerebral edema has been implicated in chronic liver disease. The purpose of this study was to compare the apparent diffusion coefficient (ADC) with the results of plasma ammonia levels and the results of neuropsychologic tests to elucidate the significance of the evaluation of ADC in diagnosing minimal HE.

MATERIALS & METHODS
This study comprised 40 patients with liver cirrhosis (20 males and 20 females; age, 66 ± 9 years). The control group consisted of 24 subjects (11 males and 13 females: age, 62 ± 9 years) who were examined at our neurologic department for minor subjective symptoms; they were free of liver diseases and neurologic or psychiatric disorders. We measured and compared the ADC in various cerebral regions (putamen, pallidus, thalamus, posterior cingulate, frontal and parietal white matters) between minimal HE patients versus no HE patients or control subjects. Cognitive function was assessed using a combination of trail-making A test and digit-symbol test.

RESULTS
In cirrhotic patients with minimal HE, mean ADC values were increased significantly in white matter such as the frontal (P < 0.01) and parietal (P < 0.05) lobes compared to patients with no HE. In patients with minimal HE, the ADC increase did not reach significance in the putamen, pallidus, thalamus or cingulate. No significant difference was found in brain ADC values between patients with no HE and control subjects. There is a degree of overlap when classifying patients without overt HE as minimal HE or no HE. Using the cut-off value of 0.841×10⁻³ mm²/sec for frontal white matter (+1 SD from the mean values for the control subjects), minimal HE patients separated from no HE patients with a sensitivity of 90% and a specificity of 90%. Using the cut-off value of 0.808×10⁻³ mm²/sec for parietal white matter (+1 SD from the mean values for the control subjects), minimal HE patients separated from no HE patients with a sensitivity of 70% and a specificity of 85%. In the patients, venous ammonia showed a linear relationship with the ADC values in the frontal (r = 0.413, P < 0.05) and parietal (r = 0.537, P < 0.001) white matter. Significant correlation of ADC values were found in frontal and parietal white matter with the results of trail-making A test in the patients (r = 0.520, P < 0.01; r = 0.483, P < 0.01, respectively). A significant correlation was found between ADC values for frontal and parietal white matter and the results of the digit-symbol test (r = -0.510, P < 0.01; r = -0.354, P < 0.05).

CONCLUSION
Apparent diffusion coefficient is a reliable tool for quantification of low-grade HE and the diagnosis of minimal HE.

KEY WORDS: Apparent diffusion coefficient, hepatic encephalopathy, cirrhosis

Diffuse Magnetization Transfer Ratio and Quantitative T2 Changes in Alzheimer Disease

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PURPOSE
In spite of the absence of a biological marker for Alzheimer disease (AD) neuronal loss is its hallmark and can be measured by regional or global atrophy. However, in the early stages of the disease, subtle changes might be lost by volumetry but may be quantified by alternative quantitative MRI techniques (qRM), such as quantitative T2 and magnetization transfer ratio (MTR). The prolongation of T2 relaxation time identifies neuropil rarefaction and MTR decrease correlates with macromolecular membrane loss. We used MTR and quantitative T2 to assess tissue changes in white matter (WM) and gray matter (GM) from normal elderly (NE) and patients with AD or mild cognitive impairment (MCI).

MATERIALS & METHODS
We studied 14 NE, 15 MCI, and 16 AD patients matched by age, respectively (mean ± SD): 70 ± 5.8, 72 ± 7.1, and 74 ± 9.8 years old. All patients and NE had a full clinical follow up and MRI obtained in 1.5 T equipment. The region of interest binary maps of WM, GM, and CSF were segmented and used for value extraction from MTR and quantitative T2 maps.

RESULTS
The MCI group was not different from the NE group, but was significantly different from the DA. The AD group was different from the NE in WM (increase of 4.8% of T2 and decrease of 6.9% of MTR), GM (increase of 9.7% of T2 and decrease of 9.5% of MTR), and atrophy, measured by brain parenchyma fraction (BPF), which was 9% lesser in AD patients. The parenchymal loss was significant only for WM but the tissue changes in GM had excellent Pearson’s correlation with WM changes either in quantitative T2 and MTR.

CONCLUSION
Our results showed the presence of and a good correlation between tissue damage in WM and GM even though atrophy was significant only for WM. The prolongation of T2 and decrease of MTR together suggest cellular loss in GM and myelin and/or axonal loss in WM, probably related to Wallerian degeneration.

KEY WORDS: Alzheimer disease, MRI, quantitative techniques
Poster 12
White Matter Lesions Are Associated with Hippocampal Atrophy in Alzheimer Disease: The Voxel-Based Specific Regional Analysis System Using MR Imaging

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Purpose
Vascular factors are thought to play a role in the etiology of Alzheimer disease (AD); however, it is still not known whether white matter lesions (WML) and hippocampal atrophy (HA) are independent or related. The purpose of this study was to investigate the relation between HA and WML in patients with AD and mild cognitive impairment (MCI) using the voxel-based specific regional analysis system (VSRAD34), which can automatically analyze three-dimensional T1-weighted MR imaging data as a series of segmentation, anatomical standardization and smoothing using statistical parametric mapping on PC Windows.

Materials & Methods
We chose 60 outpatients with a clinical diagnosis of probable AD (n = 35; mean age: 78 +/- 6 years; Mini-Mental State Examination (MMSE): 18.6 +/- 4.1) or MCI (n = 25; mean age: 74 +/- 7.1 years; mean MMSE score: 26.7 +/- 2.9) in the Memory Clinic of Tachikawa Hospital, Tokyo, Japan, and performed neuropsychological examinations and 1.5 T MR imaging for all patients. Laboratory tests included complete blood count, serum electrolytes, liver and renal function tests, thyroid function tests, and serum B1, B12 and folate levels. We compared the frequency of the associated risk factors for cerebral infarction (the histories of hypertension, diabetes mellitus, hyperlipidemia, current medication use, coronary heart disease, smoking and alcohol use). Atrophy rates of four different numerical values - entorhinal Z score, whole brain atrophy rate, entorhinal atrophy, entorhinal/whole brain atrophy ratio were determined using VSRAD50. Presence of WML was rated from axial T1, T2 and coronal FLAIR MR images using a semiquantitative classification scale. This system scores subcortical deep white matter (NAWM) and gray matter (NAGM). The WML severity was determined range 0 to 5. In subcortical WML, left and right hemispheres were rated separately and sum up. The brain distinguished five areas: frontal, parieto-occipital, temporal, infratentorial/cerebellum and basal ganglia. The WML severity was determined range 0 to 5. In periventricular WML, left and right hemispheres were rated separately and sum up. The brain distinguished three areas: frontal, parieto-occipital, temporal, infratentorial/cerebellum and basal ganglia. The WML severity was determined range 0 to 5. In periventricular WML, left and right hemispheres were rated separately and sum up. The brain distinguished three areas: frontal, parieto-occipital, temporal, infratentorial/cerebellum and basal ganglia. The WML severity was determined range 0 to 5. The binary region-of-interest maps of NAWM and NAGM, the histogram, entropy value and the map of WML severity where the mean of CN was 1.062 ± 0.137 and of the MS was 0.2907 ± 0.0689. The spearman’s correlation indicated a reasonable correlation with EDSS. For the WM values the coefficient was -0.390 (p = 0.0005) and for the GM values the coefficient was -0.290 (p = 0.0101).

Results
There were linear relations between atrophy rates of four values and neuropsychological examination’s score in AD, but no relation in MCI. Statistical analysis showed a significant correlation between the hippocampal and entorhinal cortex volumes and MMSE score (r = -0.71) in AD patients, while no correlation in MCI patients (MMSE: r = 0.05 ). Degree of WML was larger in AD than in MCI. A linear relation was found between the degree of WML and the hippocampus and entorhinal cortex atrophy in AD, which suggests that vascular factors and typical AD pathology are related.

Conclusion
Our finding suggests that hippocampal and entorhinal cortex volumes were more sensitive predictors of progression than neuropsychologic examinations. Vascular pathology and AD pathology are related. The WM may be a predictor of the course of the disease and a potential treatment target in AD. Our finding may be another step in providing a rationale on how vascular factors ultimately could result in AD.

Key Words: Alzheimer disease, white matter lesions, hippocampal atrophy

Poster 13
Analysis of Magnetization Transfer Ratio Histograms in Multiple Sclerosis Using Shannon’s Entropy

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Purpose
Magnetization transfer ratio (MTR) histograms have the potential to characterize loss of myelin in multiple sclerosis (MS) and subtle diffuse changes in other white matter diseases. In this study, we proposed the use of Shannon’s entropy for MTR histogram’s analysis to better differentiate normal controls (NC) and MS patients. The entropy concept has been used successfully to quantify system information with a wide range of applications, and we hypothesized that it may optimize the potential of MTR histograms in identifying subtle abnormalities in normal-appearing white matter (NAWM) and gray matter (NAGM).

Materials & Methods
We studied 20 NC and 58 clinically defined MS patients, including 41 in the relapsing-remitting phase, 12 secondary progressive, and 5 primary progressive patients. The average age was respectively 36.45 ± 11 years, and 35.3 ± 10 years (mean ± SD). The binary region-of-interest maps of NAWM and NAGM, the histogram, entropy value and the map of MTR were computed after automatic segmentation of visible lesions.

Results
The t-student’s test showed a significant difference between groups. When compared, the entropy values of WM showed a significant difference (p = 0.000), where the mean of CN was 1.197 ± 0.103 and of the MS was 0.2907 ± 0.0689. The GM values showed a significant difference (p = 0.000), where the mean of CN was 1.062 ± 0.137 and of the MS was 0.0966 ± 0.0462. The spearman’s correlation indicated a reasonable correlation with EDSS. For the WM values the coefficient was -0.390 (p = 0.0005) and for the GM values the coefficient was -0.290 (p = 0.0101).
CONCLUSION
This study has shown the new application of entropy in MTR histogram analysis. This descriptor was able to improve tissue lesion differentiation between MS patients and normal controls. These results suggest that entropy observed in MTR is sensitive to the complexity loss in tissues altered by MS patient.

KEY WORDS: Multiple sclerosis, MRI, quantitative techniques

Poster 14

MR Imaging Demonstrates Differential Atrophy of Tegmentum of Midbrain and Pons in Dentatorubral-Pallidoluysian Atrophy

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PURPOSE
Dentatorubral-pallidoluysian atrophy (DRPLA) is an autosomal dominant neurodegenerative disorder characterized by an unstable CAG trinucleotide repeat in the DRPLA gene on chromosome 12q12, leading to pathologic changes in the brain. Several studies emphasize the utility of mid-sagittal MRI for the diagnosis of neurodegenerative disorders including DRPLA, progressive supranuclear palsy and Machado-Joseph disease. Our purpose here is to clarify the differences between abnormal atrophy seen in patients with DRPLA and normal developmental and aging patterns of the brainstem.

MATERIALS & METHODS
We measured the area of the midbrain tegmentum (A), tectum (B), basis pontis (C), and pontine tegmentum (D) on mid-sagittal MR images in 23 patients with DRPLA (10 males and 13 females) and 306 normal individuals (newborn to 89 years old). One hundred fifty males and 156 females, normal healthy individuals were each divided into 15 age groups (0-5 months, 6-12 months, 13-23 months, 2-3 years, 4-5 years, 6-9 years, 10-14 years, 15-20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years, 61-70 years, 71-80 years, 81-90 years). Each area of the midbrain structures in patients with DRPLA was compared with the corresponding area in normal subjects of the same age range. All DRPLA patients were diagnosed by molecular analysis of the DRPLA gene. The age of DRPLA patients ranged from 4-69 years (mean age 45.0 years old).

RESULTS
In DRPLA patients the areas of midbrain tegmentum and pontine tegmentum appeared significantly smaller than those of the normal control at each age group, in both male and female groups. Statistical studies revealed that there were differences in the midbrain tegmentum (p < 0.001) and pontine tegmentum (p < 0.001) between the female DRPLA group and the normal female group of the same age range, also that there were differences in the midbrain tegmentum (p < 0.001) and pontine tegmentum (p < 0.001) between the male DRPLA group and the normal male group of the same age range. In pediatric DRPLA patients (4, 7 and 13 years old), the areas were smaller by beyond two standard deviation (SD) from those of the normal control group.

CONCLUSION
Mid-sagittal MR imaging of the head is accurate and reproducible and can be used conveniently in routine head MR studies. We believe that this new milestone provided in this study will help distinguish DRPLA patients from the normal individual.

KEY WORDS: Dentatorubral pallidoluysian atrophy, MRI
Multimodal Quantitative MR to Characterize Brain Tissue Damage in Multiple Sclerosis

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Purpose
To use a combination of quantitative magnetic resonance techniques (qMR) to characterize tissue damage in MS patients, assuming T2 and T1 lesion volume as a marker of the disease burden, the number of enhancement lesions as a marker of inflammation, brain atrophy as a parameter of tissue loss, quantitative T2 as a measurement of water tissue density (gliosis, demyelination, edema or axonal damage), magnetization transfer ratio (MTR) as an indicator of myelin destruction, and MR spectroscopy with NAA quantification as a measure of axonal metabolic dysfunction.

Materials & Methods
We studied 58 clinically defined MS patients, including 41 in the relapsing-remitting (RR) phase, 12 secondary progressive (SP), and 5 primary progressive (PP) patients. Twenty normal controls (NC) were studied for comparison. Patients and controls were evaluated extensively and had an MRI qualitative and quantitative exam performed using 1.5 T superconductive equipment. The Kurtzke expanded disability status scale (EDSS) was used to quantify disability.

Results
Although T1 and T2 lesion volume were not significantly different between MS subgroups, the number of lesions as well as their destructivity measured by quantitative T2 and MTR was different. Quantitative T2 and MTR were different in normal-appearing white matter (NAWM) and gray matter (NAGM). NAA reduction was present even in low disability patients (EDSS ≤ 1.0), whereas brain atrophy was not, as measured by brain parenchyma fraction. Higher correlations with disability were found with NAA-reduction and atrophy, but it was also good between EDSS and MTR and quantitative T2 of the NAWM or NAGM. The measurement over time showed a rate of 1.72% brain atrophy per year.

Conclusion
The multimodal qMR allowed the characterization of the pattern of brain tissue destruction in MS with early axonal damage, measured by NAA reduction and atrophy which was more evident in progressive patients. The lesions are more numerous and more destructive in the SP phase. The NAWM and NAGM have tissue damage even in low disability patients. The lesion volume was less sensitive than the number of lesions in measuring the progression of the disease; however, the combination of different modalities of qMR adds important information to qualitative MRI following MS patients.

Key Words: Multiple sclerosis, MRI, quantitative techniques

Comparison Diabetic and Nondiabetic about Hippocampal Atrophy on Volume-Based Morphometry

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Purpose
It is reported that frequency of cognitive function degradation in diabetic mellitus is higher than that in nondiabetics. Some epidemiologic studies reported that incidence of Alzheimer disease (AD) of elderly patients of type 2 diabetes mellitus was about 2 times that in nondiabetics. For early diagnosis of Alzheimer disease, utility of hippocampal regional volume-based morphometry (VBM) is proposed. In this examination, we compared the severity of atrophy of hippocampal region and brain parenchyma between diabetic group and nondiabetic control group by using VBM.

Materials & Methods
Our subjects were 29 diabetic patients (male::female =15:14, age 59-79 years old, mean age 70.7 years old) and sex- and age-matched (+/- 2 years) 29 nondiabetic healthy volunteers. Volume-based morphometry of whole brain and hippocampal region was performed on 1.5 T MR unit (Magnetom Symphony [Siemens]) with following parameters; 3D-GRE imaging (MPRAGE), TR/TE/TI: 1750/3.93/1 100 (msec), FA:15, matrix: 256 x 256, FOV : 22 cm, slice thickness: 1.5 mm, 120 slices. Following 3 factors were investigated: (1) the severity of hippocampal atrophy (mean value of Z score in region of interest), (2) the ratio of cerebral atrophy (Z score > 2) region to the whole brain, (3) the atrophy severity ratio of the hippocampal region to whole brain. The statistical analysis was performed with unpaired t-test and its significance level was assumed with less than 1% (P< 0.01) of critical rate.

Results
There was a significant difference between diabetics and nondiabetics about the severity of hippocampal atrophy and the ratio of regional cerebral atrophy region. Only in diabetic group, positive correlation between the ratio of regional cerebral atrophy and the severity of hippocampal atrophy was recognized (Spearman’s two-tail correlation, correlation function: rs = 0.775, P < 0.01).

Conclusion
Acceleration of cerebral atrophy especially at hippocampus is significant in diabetics in comparison with nondiabetics. Our results prove relation of diabetes mellitus and hippocampal atrophy and support high frequency of Alzheimer disease in diabetics.

Key Words: VBM, diabetes, dementia
Posters

Study of the “Dirty White Matter” Regions in Patients with Multiple Sclerosis with Diffusion Tensor Imaging, Perfusion-Weighted Imaging, and MR Spectroscopy

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Purpose
To apply the DTI, PWI and MRS techniques in patients with MS, for the better characterization of the dirty white matter (DWM) regions.

Materials & Methods
Twenty patients with relapsing-remitting MS were studied on a 1.5 T MR scanner. A T2SE-EPI sequence with 6 different diffusion gradients, a single shot T2* GRE-EPI sequence with 50 dynamic axial scans after a single dose of Gd administration, and a 2D PRESS multivoxel sequence were applied for the DTI, PWI and MRS, respectively. Two hundred forty-four measurements of the apparent diffusion coefficient (ADC), fractional anisotropy (FA), relative cerebral blood volume (rCBV), N-acetylaspartate/Creatine (NAA/Cr), Myoinositol/Creatine (mI/Cr) and Choline/Creatine (Cho/Cr) values were performed concerning normal appearing white matter (NAWM = 76), DWM (46) and focal white matter lesions (122). Significant difference among the ADC, FA, rCBV, NAA/Cr, ml/Cr and Cho/Cr values of the measured white matter regions was evaluated, by using student’s t-test.

Results
Dirty white matter regions demonstrated significantly higher rCBV (p = 0.02), ADC (p < 0.0005), and ml/Cr (p < 0.0005) values and lower FA (p = 0.02) values compared to NAWM and significantly different values compared to most of the focal white matter lesions. There was no significant difference between the rCBV, ADC, FA, NAA/Cr and Cho/Cr values of the DWM and the respective values of the focal isointense, on T1 sequence, lesions (= ISO), while ml/Cr values of the DWM were significantly higher (p = 0.04) compared to that of the ISO.

Conclusion
Dirty white matter regions are characteristic of high regional blood volume, increased diffusivity, decreased fractional anisotropy, and increased mI/Cr values, while they do not demonstrate significant differences compared to the active focal white matter lesions. These probably reflect diffuse inflammation and demyelination at the DWM regions that precede the acute active focal lesions formation.

Key Words: Multiple sclerosis, dirty white matter

Poster 17

Arterial Spin Labeling in Assessment of Functional Circuitry Involved with Cognition and Memory in Cognitively Normal Elders, Alzheimer, and Mild Cognitive Impaired Individuals

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Purpose
To assess patterns of blood perfusion using arterial spin labeling (ASL) in functional circuitry involved with cognition and memory in cognitively normal (CN), mild Alzheimer disease (AD), and mild cognitive impaired (MCI) patients with and without hypertension.

Materials & Methods
Thirty-two cognitively normal age-matched elders (16 without hypertension), 22 AD (14 without hypertension), and 25 MCI (18 without hypertension) patients underwent modified ASL imaging using alternating single and double adiabatic inversions (ASD) (3.7 s pulse train at 92% duty cycle) and ramp-sampled echo-plane imaging (EPI) to acquire 19 contiguous axial slices [64×64 matrix, 20 cm field-of-view, 5 mm slice thickness, 0 spacing, 21 ms echo time (i.e., minimum full), 76 kHz effective receiver bandwidth, 1 s acquisition time, 700 ms transit delay, 900 flip angle]. Thirty-eight CN rCBF were averaged for 12 regions identified by Talairach atlas as controls: hippocampus, superior temporal, globus pallidus, amygdyla, orbitofrontal, anterior and posterior cingular, lateral prefrontal, superior parietal, precuneus, thalamus, and lentiform. Small delta (rCBF subtracted from averaged CN rCBF), large delta (rCBF differences between hypertensive and nonhypertensives), principal component analysis (PCA), and partial least squares (PLS) analysis were performed on these 12 targeted regions. Voxel-based morphometric studies also were done to assess for atrophy.

Results
Voxel-based morphometric (VBM) showed minimal but definite regions of atrophy, but too small to affect overall rCBF in targeted regions. Small and large delta showed significant deviations from normal in the posterior cingular and precuneus cortex (>2 standard deviations), with increase in rCBF in the MCI group compared to CN and AD which showed decreased rCBF. Principal component analysis and PLS also identified the posterior cingulate, precuneus, prefrontal cortex, and basal ganglia nuclei as significant regions of rCBF deviation.

Conclusion
Key functional circuits are the prefrontal/orbitofrontal to anterior cingulate, and the posterior cingulate to precuneus circuit with both having considerable interconnections with the basal ganglia, limbic system, and medial temporal lobe. Memory, cognition, and behavior are defined by these circuits. These regions tend to have the higher rCBF values. Differences in rCBF were observed comparing the nonhypertensives with the hypertensives. Visual inspection of the ASL images revealed more areas of hypoperfusion comparing AD to CN, but less so with MCI. Hypertensives showed more areas of hypoperfusion. There were also areas of asymmetry in perfusion of basal
ganglia with areas of increased perfusion in MCI patients. These areas of visual changes are confirmed by the quantified rCBF as well as by the statistical analyses. The basal ganglia particularly the thalamus appears to be key in identifying perfusion changes in the transition from CN to MCI to AD, although more definitive work needs to be performed. Although perfusion is not a direct measurement of functional changes, ASL does provide a safe, noninvasive, and easily reproducible means of assessment comparable to the more invasive and definitive PET scanning with O15.

**KEY WORDS:** Arterial spin labeling, Alzheimer, mild cognitive impairment

**Poster 19**

**Morphologic Evaluation of Brain Degenerative Disorders Based on Volume-Based Morphometry Analysis**

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**PURPOSE**

In MR evaluation of brain degenerative disorder, evaluation of brain atrophy pattern (localization and severity) is an important clue to correct diagnosis. However, in aged person, pathologic atrophy often coexists with physiologic brain atrophy (aging changes) and diagnosis of brain atrophy often annoys us. Induction of simple, objective and accurate diagnostic tool for diagnosis of brain atrophy is expected.

**MATERIALS & METHODS**

Morphologic evaluation of brain atrophy based on volume-based morphometry (VBM) was performed in nine patients of brain degenerative disorder with brainstem cerebellum atrophy; three spinocerebellar degeneration cases, four multiple system atrophy cases and two cerebellar degenerative disorder cases and same analysis was performed on nine age-matched healthy control subjects. For VBM analysis, 3D-GRE imaging (MPRAGE) was adapted with following parameters; TR/TE/TI = 1750/3.93/1100 (msec), FA = 15, Matrix: 256 x 256, FOV: 22 cm, slice thickness: 1.5 mm, 120 slices.

**RESULTS**

The severity of regional atrophy at brainstem and cerebellum was evaluated with Z score quantitatively and brain atrophy map based on Z score analysis distinguished physiologic atrophy and pathologic atrophy at brainstem/cerebellum and exhibited its characteristic pattern and severity distinctly.

**CONCLUSION**

Morphologic evaluation of pattern of brain atrophy based on VBM is contributes for early diagnosis of degenerative disorders such as spinocerebellar degeneration, secondary cerebellar degeneration, multiple system atrophy as well as major brain degenerative disorder; Alzheimer disease, frontotemporal lobe dementia, diffuse lewy body dementia, corticobasal degeneration.

**KEY WORDS:** Morphologic evaluation of brain degenerative disorder, MRI, brain atrophy

**Poster 20**

**Posterior Reversible Encephalopathy Syndrome**

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**PURPOSE**

To study the causes, risk factors and imaging for the development of posterior reversible encephalopathy syndrome (PRES).

**MATERIALS & METHODS**

Patients with clinical and neuroimaging features consistent with PRES were studied. Clinical history and imaging findings of 16 patients, including conventional magnetic resonance imaging (MRI), diffusion-weighted imaging (DWI), and calculated apparent diffusion coefficient (ADC) maps, were used to establish the diagnosis of PRES. All had CT and/or MRI brain scan and other hematological and serological investigations to determine the most likely cause of the syndrome. Most patients also underwent follow-up neuroimaging to demonstrate resolution of brain lesions. Risk factors for PRES like hypertensive encephalopathy, immunosuppressive treatment, transplantation, eclampsia, vasculitis endocrine disorders, hemolytic uremic syndrome, hypercalcemia, and blood transfusion were studied.

**RESULTS**

Fifteen patients fulfilled the clinical and radiologic features consistent with PRES. Seizures and altered conscious level were most common clinical manifestations. Main radiologic feature on CT and/or MRI brain was extensive subcortical edema mainly confined to the posterior parieto-occipital lobes. Hypertensive encephalopathy (8), eclampsia (5), immunosuppressive treatment (2), and liver transplantation (1) were main causes of PRES in our study. We also found that this syndrome was more common in females than males. Clinically all patients recovered with control of blood pressure and discontinuation or reduction in dose of the offending drug within 2-7 days. There was almost complete resolution of radiologic abnormalities within 2-4 weeks in patients who underwent follow-up imaging.

**CONCLUSION**

Hypertensive encephalopathy, immunosuppressive treatment, liver transplantation, and eclampsia are most common causes of PRES with a greater predilection for females than males.

**KEY WORDS:** PRES
Poster 21
Withdrawn

Poster 22
Simultaneous Electroencephalogram-Functional MR Imaging Recording of Interictal Activity in Drug-Refractory Focal Epilepsy
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PURPOSE
In patients with drug-refractory focal epilepsy, recent magnetoencephalographic (MEG) studies showed that to include in the cortical excision the area of interictal activity may improve the outcome of the epilepsy surgery (Fisher 2005). However, using the standard electroencephalogram (EEG) from the scalp, interictal activity can be evaluated only approximately. A new approach to the interictal activity is simultaneous EEG-fMRI recording (Gotman 2006): the interictal spikes recognized on the EEG can be used as a model of the BOLD response. The initial experience at the Neurological Institute C. Besta (Milan, Italy) is presented here: among 7 patients with a complete EEG-fMRI dataset, 4 patients showed at least 4 interictal events. Here are reported only clinical and imaging data of the 3 patients with significant BOLD change using the conventional analysis.

Patients: 3 male patients (33 ± 11 years) with drug-refractory temporal lobe epilepsy (pt 1: temporomesial sclerosis and large CSF cyst, pt 2: temporomesial DNET, pt 3: temporomesial sclerosis). Ictal focus, based on video-EEG recordings, was temporal-parietal in pt 1, temporomesial in patients 2 and 3. At the time of abstract submission, patients 1 and 2 were subjected to amygdalo-hippocampectomy (plus cyst fenestration in pt 1) after the EEG-fMRI recording.

MATERIALS & METHODS
Electroencephalogram in the scanner was recorded by an EBNeuro Misar-MR system (Florence, Italy). In a Siemens Avanto 1.5T scanner, 4-8 functional runs were acquired. Each run, lasting 6’40”, was composed of 100 EPI scans (TR=52 ms, TE=3000 ms, voxel size isotropic 4mm).

Anatomical T2 in-plane and high-resolution MPRAGE were also acquired. Functional MRI data were analyzed using SPM2: after motion correction and spatial-temporal filtering, event-related analysis was carried out using as events the occurrence of the epileptic spikes on the EEG traces.

RESULTS
Using EEG online filtering (EBNeuro Galileo), the occurrence of epileptic spikes was recognizable. In pt 1, BOLD change was located at the temporoparietal junction, and in the ipsilateral and contralateral frontal lobe. The cyst fenestration resulted in decompression of the temporoparietal cortex, and complete seizure remittance (> 1 year after surgery). In pts 2 and 3, BOLD change was in the temporomesial cortex: temporal pole in pt 2, parahippocampal gyrus in pt 3. The temporopolar area was included in the surgical resection of pt 2, and is now seizure-free (1 year after surgery). Patient 3 presented with an ipsilateral and a contralateral orbitofrontal activation, and requires surgery.

CONCLUSION
Electroencephalogram-fMRI is feasible in a clinical setting, and can produce an accurate map of the interictal activity. In our small sample of patients with temporal lobe epilepsy, the occurrence of epileptic spikes during the EEG-fMRI session was employed successfully to produce a fMRI map of the interictal area well correlated with the seizure focus, as supposed on the basis of the video-EEG findings and confirmed by the outcome from the surgery. However, the clinical relevance of extratemporal areas of BOLD change remains to be explained, and more sophisticated analysis of EEG-fMRI datasets are mandatory to extract temporal information from the different brain areas involved in the interictal activity.

KEY WORDS: Temporal lobe epilepsy, interictal area, EEG

Poster 23
Tactile and Gustatory Representations of the Tongue in the Two Hemispheres: A Functional MR and Diffusion Tensor Imaging Study
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PURPOSE
The present study aimed at establishing the contribution of the corpus callosum (CC) to the bilateral representation of unilateral tactile and taste stimuli in SI and GI, respectively, using 1.5 T functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI).

MATERIALS & METHODS
Unilateral stimulation of the tongue was applied to 12 control subjects and 6 patients with callosal resection performed to treat severe epilepsy. The protocol was approved by the Ethical Committee of Università Politecnica delle Marche Medical School (Ancona, Italy). Data were analyzed with BrainVoyager, SPM2 and Functool softwares.

RESULTS
In control subjects and 5 callosotomized patients (2 with total, 1 with partial anterior and 2 with partial posterior resection), unilateral stimulation evoked activation of area GI and of SI in both hemispheres. In the remaining patient with total callosotomy, left hemitongue stimulation activated ipsilateral GI and bilateral SI, while right stimulation activated GI and SI in both hemispheres. The mean Talairach coordinates of GI and SI activation foci were not significantly different between control subjects and patients (p > 0.05). Significant activation also was detected in pontine areas during salty stimulation in controls and in patients. Analyzing the diffusion of water molecules along different directions DTI enables the virtual reconstruction of axonal fibers. Diffusion tensor tractography showed that in control subjects and in patient with posterior CC resection, the fibers interconnecting GI in the two hemispheres cross the anterior
CC. In patients with anterior and total resection, areas GI are connected through subcortical structures, likely the pontine parabrachial nucleus.

**Conclusion**

The present results confirm previous neuropsychological findings suggesting that gustatory pathways from tongue to cortex are bilaterally distributed, with an ipsilateral predominance. It can be hypothesized that gustatory stimulus reaches ipsilateral area GI via the solitary tract nucleus, then projects to ipsilateral GI via a thalamic relais, and then to contralateral GI through CC. In control subjects, GI bilateral activation thus appears to be mediated by the anterior portion of the CC. The bilateral activation of GI area detected in patients lacking the anterior part of CC could be mediated by a pathway originating in a pontine nucleus, projecting to the thalamic nuclei of both hemispheres and then to GI areas.

**Key Words:** Taste cortical representation, lateralization, brain imaging

**Poster 24**

**Comparison of Various Functional MR Imaging Paradigms for Determination of Language Critical Areas in Human Cerebral Cortex in Persian Native Speakers**

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**Purpose**

Functional magnetic resonance imaging (fMRI) plays a significant role in preneurosurgical planning at present. Functional MRI replaces older invasive methods to determine language dominant hemisphere and cortical areas associated with speech and language. Nevertheless, ideal protocols for language assessments that have been accepted as a routine clinical application have not developed yet. In this study, two novel tasks were developed and compared with three older ones in Farsi. We found the optimal paradigm as presented here among all proposed tasks.

**Materials & Methods**

Fourteen healthy right-handed Persian speaker volunteers have been examined in this study. For each subject, five Persian tasks were performed whilst their brain activations were monitored by fMRI. Word generation (WG), object naming (ON) and word reading (WR) were selected from similar prior studies in other languages and word production (WP) and reverse word reading (RWR) were suggested by us. Each task prolonged for 3 minutes and 20 seconds with 8 blocks of rest and activation alternatively. Fifteen continuous slices, parallel to AC-PC line, were acquired with TR = 3150 ms and TE = 60 ms. The final analysis on data was carried out using FSL (FMRIB Software Library). At last, the result for each subject-task was assessed and the ability of each task to activate classical language areas was evaluated by group analysis. In addition, Lateralization index (LI) for each subject-task was calculated and compared.

**RESULTS**

It was shown that “WP” and “RWR” could trigger robust activation in dominant hemisphere as well as brain critical areas related to language better than “ON”, “WR” and “WG” tasks. In addition, the result revealed that the activation intensities with these tasks were higher in anterior cerebral regions. The region of interest (Broca’s Area) located in Left Inferior Frontal Gyrus was activated in most of the subjects performing “WP”, “RWR” and “WG”. “WR” could do this to some extent and “ON” has almost failed to demonstrate this area. Evaluation of LIs revealed that “WP” and “RWR” could monitor brain activity in left hemisphere better than other paradigms. “ON” failed to demonstrate the dominant hemisphere in some subjects.

**Conclusion**

Our results demonstrated that previous tasks suggested by other researchers can be replaced by “WP” and “RWR” because of their enhanced lateralization of the dominant hemisphere and also due to their intensive activation in Broca’s area. Consequently, we can employ these tasks as a routine protocol to reveal precise location of Broca’s area prior to neurological surgery. We recommend application of this optimized protocol in patients with frontal brain tumors or arteriovenous malformations, who are candidates for surgery, in future trends.

**Key Words:** fMRI, language

**Poster 25**

**Automated Generation of Diffusion Tensor Tractography Maps**

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**Purpose**

Diffusion MR tractography provides a unique perspective on the structure of white matter that is proving increasingly useful in neurosurgical planning (1). However, production of tractographic images is highly operator-intensive, generally requiring an experienced user to place seed and target regions of interest (ROIs) that must often be refined over multiple iterations to constrain the output into an appropriate format. We developed a method to automate tractography of several major fiber tracts in healthy controls. Unlike conventional streamline tractography, this method has very little need for user intervention once diffusion tensor MR images are acquired.

**Materials & Methods**

Seed and target ROIs were defined a priori on a standard template. Each seed and target consisted simply of a combination of prelabeled cortical regions (2). Diffusion tensor MR images were acquired on a 3.0 T scanner using 12 motion-probing gradients and a b-value of 800 s/mm². Images from individual study participants were registered to the template using a nonlinear algorithm (HAMMER) (3), which also was used to import seed and target ROIs directly into subject space without user intervention. Probabilistic tractography then was carried out using FSL-FDT (4). Four
tracts were evaluated bilaterally: the cingulum, the inferior longitudinal fasciculus, the superior longitudinal fasciculus, and inferior fronto-occipital fasciculus. Conventional streamline tractography was also performed on a subset of this group by an experienced tractographer using Volume One-dTV (5).

RESULTS
Automated tractography was able to produce probability maps for most white matter fiber tracts in a reliable fashion. The morphology of these tractography maps was comparable to the results obtained using a conventional streamline tractography program (Fig). Automated tractography results were more amenable to voxel-based statistical analysis, permitting the identification of subtle differences between normal males and females. However, automated tractography was computationally intensive, generally requiring several hours of offline processing to produce maps of each fiber tract.

(Above) Automated tractography of the inferior fronto-occipital fasciculus.
(Below) Conventional tractography of the inferior fronto-occipital fasciculus.

CONCLUSION
Automated tractography can produce results that are comparable to conventional methods. The reduction in operator-dependence may accelerate the incorporation of diffusion tractography into clinical practice by freeing the neuroradiologist from close supervision of the tractographer. This method will benefit greatly from advances in computer processing speed.

REFERENCES
5. European Jrl Radiol 2003;46:53-66

KEY WORDS: DTI, tractography

Poster 26
Fiber Tracking of the Limbic System in Mild Cognitive Impairment and Alzheimer Disease
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PURPOSE
Alzheimer disease (AD) is a progressive neurodegenerative disorder that causes memory impairment by damaging components of the limbic system. We hypothesize that the major pathways of this system will reflect neuronal dysfunction occurring during incipient and early AD, and that these changes can be identified with diffusion tensor imaging (DTI). We performed DTI-based tractography and analysis of fractional anisotropy (FA) values to investigate the integrity of fornix and cingulum fiber bundles in healthy controls (NC), individuals with mild cognitive impairment (MCI), and those with AD.

MATERIALS & METHODS
DTI data were obtained with the following parameters: EPI, b=1000 applied along 6 directions, 3 mm2 in-plane resolution, interpolated to 1.5 mm2, 3 mm slices, 4 NEX. Data from 12 NC, 10 AD and 20 MCI were analyzed. DTI Studio software was used for fiber-tracking of the cingulum bundle and the body of the fornix (FB) as well as the posterior limb of the internal capsule (IC) (as a control region). We then selected 9 regions of interest (ROI) from these tracked structures for which we obtained volume and FA data: FB and bilateral superior cingulum, descending cingulum, temporal cingulum (its terminus near the hippocampal region) and IC. Separate ANOVAs were performed for structure volume and average FA. Age and education were included as covariates.

RESULTS
For analysis of volume, group membership was significant (F=11.3; p<0.0001) (control v MCI v AD). Furthermore, on posthoc comparisons, the control and AD groups were significantly different from each other (p<0.0001), as were the MCI and AD groups (p=0.014). The contrast between NC and MCI was not significant (p=0.09). When examining individual regions, FB was not only significant (F=9.7; p<0.0001) but discriminated among all 3 groups on posthoc testing. ROIs within the cingulum distinguished NC from AD, and the left descending and temporal cingulum discriminated NC from MCI. Internal capsule was not significantly different between groups. For analysis of FA, group membership was again significant (F=14.9; p<0.0001), and posthoc testing indicated that NC were significantly different from AD subjects (p<0.0001) and from those with MCI (p=0.001), but MCI were not distinguishable from AD (p=
0.12). When examining individual regions, FB was again significant (F=6.9; p<0.0001), and discriminated NC from AD as well as NC from MCI, but not MCI from AD. Regions of interest within the cingulum were similarly able to distinguish NC from AD, and the left superior cingulum and right temporal cingulum discriminated NC from MCI. Internal capsule was, again, not significantly different between groups.

CONCLUSION
1. Both volume and FA of FB and cingulum bundle decline along a continuum between NC, MCI and early AD, and can be used to distinguish NC from AD. 2. This phenomenon is unlikely to be related to a generalized process, as volume and FA of IC remain constant across groups. 3. Although preliminary, our data suggest that FA of key limbic system pathways may decline at an earlier stage of disease than volume and may thus be more sensitive in detecting evolving AD.

KEY WORDS: Diffusion tensor, mild cognitive impairment, Alzheimer disease

Poster 27

Visualization of Fiber Projection from Medial Premotor Areas Using Diffusion Tensor Fiber Tractography

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PURPOSE
To visualize projection fibers originating from medial premotor area using diffusion tensor fiber tractography in healthy subjects and patients with brain tumor, and to define the anatomical location and organization of the fiber bundles in relation to the corticospinal tract from primary motor area.

MATERIALS & METHODS
Subjects comprised 13 healthy volunteers and 10 patients with brain tumor close to cortical motor areas or corticospinal tract. Fibers from medial premotor areas to brainstem as well as the corticospinal tract were reconstructed from diffusion tensor imaging using 3.0 T scanner. Fiber assignment by means of continuous tracking (FACT) method was applied for fiber tractography. The two fiber bundles were viewed by using 3-dimensional (3D) reconstruction and 4 transverse planes (corona radiata, posterior limb of internal capsule, cerebral peduncle and brainstem) to define the apparent anatomical relationship in the brain.

RESULTS
Corticospinal tracts were visualized bilaterally in all the subjects. Fibers from medial premotor area were visualized bilaterally in eight healthy subjects and four patients with brain tumor, left only in three healthy and four patients, right only in one healthy and one patient, and were not visualized in the remaining one healthy and one patient. Fibers from premotor areas were located anteriorly at the level of corona radiata, anterior medially at the level of internal capsule, medially at the level of cerebral peduncle, and located posteriorly in the brainstem in all visualized hemispheres but one healthy hemisphere. In this healthy subject, fibers from right premotor area were located laterally at the level of cerebral peduncle. Six patients visualized the fibers from medial premotor areas in the affected hemisphere, three of them were displaced by the lesions, and the somatotopic organizations of the two bundles were maintained in those hemispheres.

KEY WORDS: Anatomy, premotor area

Poster 28

Impact of CT Perfusion in the Diagnosis and Management of Acute Stroke: A Prospective Study

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PURPOSE
This is a unique prospective study evaluating the value of CT perfusion in the assessment and management in acute stroke patients in a busy major stroke center.

MATERIALS & METHODS
Since October 2007, our institution has implemented a protocol that includes CT perfusion imaging on all patients presenting with a suspected stroke. Our stroke center is very busy with a high interventional rate. We have evaluated prospectively 47 patients thus far and plan to continue using this protocol and collecting data until April 2008. We expect to collect a study sample of over 300 patients. Mean transit time (MTT), cerebral blood flow (CBF), and cerebral blood volume (CBV) are calculated in each case. Mapping is used to visualize infarct core and tissue at risk (penumbra) volumes. CT angiography of the head and neck is performed on selected cases. A CT or MRI head is performed as a follow up at 24 hours from presentation. Imaging results then are correlated to the clinical presentation. This includes time of stroke onset and symptoms, if known, time to CT perfusion, time to IV TPA administration and time to intervention, if applicable. Then, we evaluate how CT perfusion impacts the path of management for each individual case and determine its impact on patient outcome. Admission and discharge
National Institute of Health Stroke Scale scores (NIHSS) will be used as a measure of clinical outcome. We also will document the incidence postintervention intracranial hemorrhage and death during hospitalization.

RESULTS
The preliminary data from the 47 cases collected thus far has shown that the results of the CT perfusion study influence the decision to perform a conventional angiogram with possible intervention. Medical management and ICU admission also is influenced by CT perfusion results. For example, a 71-year-old male last seen neurologically intact at bedtime awoke with right hemiplegia, aphasia and right-sided vision loss. On initial evaluation, his NIHSS score was 34. This patient would traditionally be outside the treatment window for IV TPA and other intervention due to unknown time of symptom onset. CT perfusion showed large area of penumbra surrounding the small left middle cerebral artery territory infarct. Due to the large penumbra volume, the decision was made to intervene with mechanical embolectomy to the left MCA occlusion and angioplasty/stent of left ICA. Patient was discharged with NIHSS score of 10.

CONCLUSION
The initial data have shown CT perfusion to be a very sensitive and useful tool in the diagnosis and management of stroke. Change in patient management, including the decision if and how to intervene, and ICU admission was seen in the majority of cases thus far.

KEY WORDS: CT perfusion, stroke

Poster 29
Tract-Specific Analysis of White Matter Pathways in Healthy Subjects: A Pilot Study Using Diffusion Tensor MR Imaging

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PURPOSE
The normal adult brain undergoes considerable morphological changes as it ages. However, to date, there are very scant data regarding the normal diffusion properties of the white matter (WM) fibers in the elderly population. Our aim was to estimate the normal diffusion tensor metrics of the WM fibers, such as the uncinate fasciculus (UF), the posterior cingulum (PC), the fornix and the corticospinal tract (CST) for healthy adults over the age of 40 years using tract-specific analysis by diffusion tensor tractography (DTT) and to elucidate effects of aging on these fibers.

MATERIALS & METHODS
This study included 100 healthy subjects aged 40-84 years (50 males, 50 females; mean age 58 ± 11 years). All scans were performed using a 3 T MRI system (Signa EXCITE HD; GE) using spin-echo echo-planar technique [repetition time (TR) = 13000 ms, echo time (TE) = 52.8 ms, matrix size = 96 × 96, field of view (FOV) = 288 × 288 mm, slice thickness = 3 mm with no gap (3 × 3 × 3 mm isotropic voxel), number of excitation (NEX) = 1]. Images were obtained with both 13-directional diffusion encoding (b value = 1000 s/mm²) and no diffusion encoding (b value = 0 s/mm²). Scanning time was 2.5 minutes. Diffusion tensor tractography of UF, PC, fornix and CST were performed by means of two ROI (region of interest) method. Diffusion tensor tractography analysis was performed using dTV II SR and VOLUME-ONE 1.72. Mean diffusivity (MD) and fractional anisotropy (FA) of the tracts were measured. Pearson correlation analysis was used to evaluate age relationship. Paired-t test was used to compare hemispheric asymmetry. Values of p<0.00625(=0.05/8) were considered to indicate statistical significance.

RESULTS
A significant increase of MD with advancing age was observed in right UF (p=0.0002) and bilateral fornix (right: p<0.0001; left: p<0.0001) with Pearson correlation analysis. Mean diffusivity values tended to increase with advancing age but the comparison of these parameters did not reach statistical significance in the left UF (p=0.0213), right PC (p=0.0147) and bilateral CST (right: p=0.0162; left: p=0.0348). A significant decline in FA was found in bilateral fornix (right: p<0.0001; left: p<0.0001) during normal aging. We did not find any significant differences in FA of UF, PC and CST. Asymmetry evaluation of FA revealed significant right-greater-than-left asymmetry in UF (P<0.0001). A trend of left-greater-than-right asymmetry was observed in PC (p<0.05). Asymmetry evaluation of MD revealed left-greater-than-right asymmetry in CST (P<0.0001). We did not find any asymmetry in MD of UF and both FA and MD of fornix.

CONCLUSION
Diffusion tensor tractography permits tract specific assessment of neural circuitry degeneration associated with aging not possible with conventional imaging modalities. Our findings can be used as normative data to evaluate changes of diseases and may provide a global assessment of normal age-related changes. Our results indicate that in tract-specific analysis patient age and hemisphere might need to be taken into account in comparing normative data in control subjects with those obtained in patients with various disease conditions.

KEY WORDS: Diffusion tensor tractography, tract-specific analysis, white matter
Poster 30
Differences in Metabolic Ratios in Different Brain Regions Associated with Pain Modulation in Systemic Lupus Erythematosus Patients Compared To Normal Controls: A Prospective 2D-CSI MR Spectroscopy Study

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PURPOSE
Systemic lupus erythematosus (SLE) is an autoimmune disease that often involves central nervous system (CNS). Patients with SLE can develop dysfunction of the CNS and have several neurologic syndromes with heterogeneous pathogenic mechanisms. In addition, symptoms of pain and sensitivity to experimental pain stimuli are common clinical findings in many SLE patients. The neurophysiology of pain processing has received increasing interest in recent years and data from multiple functional imaging techniques consistently identify the same brain structures, termed the “pain matrix”, that are activated during painful conditions. Our purpose was to assess for metabolic alterations as defined by proton magnetic resonance spectroscopy (1H-MRS), in a number of brain regions implicated in pain processing between SLE patients and normal controls (NC) and also correlate metabolic data to clinical symptoms.

MATERIALS & METHODS
A prospective study of 10 SLE patients without neuropsychiatric manifestations (9 females, 1 males, aged 27-59 years, mean 42 years) and 11 age- and gender-matched normal controls (NC) who had conventional MRI and 2D-CSI MRS performed on a 3 T MR scanner (Archiva, Philips, Netherlands). All subjects had a clinical work up including laboratory tests, mini mental test, and clinical and experimental pain testing. Two-dimensional CSI was performed (TE/TR 144/2000 ms) with a volumes of interest (VOI) placed at the level of the basal ganglia and periventricular gray matter. Within these larger areas, manually placed ROI of equal size were placed in normal appearing white and gray matter in regions previously implicated in pain processing. Metabolic peaks for N-acetyl-aspartate (NAA), choline (Cho), creatine (Cr), and presence of lactate/lipids (LL) and their ratios (NAA/Cr, NAA/Cho, Cho/Cr) were determined. For statistical analysis t-test with two-tailed distribution and their ratios (NAA/Cr, NAA/Cho, Cho/Cr) were determined. A p < 0.05 (uncorrected) was set for statistical significance.

RESULTS
Common findings on conventional imaging were nonspecific small focal lesions of increased signal on T2-weighted and FLAIR images, mild brain volume loss present in some patients. An incidental finding of a right internal carotid aneurysm was present in one of the controls. Both NAA/Cr and Cho/Cr ratios varied depending on location in both groups. The Cho/Cr was significantly higher in right thalamus (mean 1.12 vs 0.95, p = 0.04) and showed a tendency to be higher in corpus callosum (mean 1.42 vs 1.01, p = 0.06), and frontal gray matter (mean 1.16 vs 0.96, p = 0.07) in SLE patients compared to NC. Significant higher NAA/Cr ratios were present in right thalamus (mean 1.8 vs 1.5, p = 0.05), in corpus callosum (mean 2.0 vs 1.84 p = 0.03), and in occipital gray matter (p = 0.02) in SLE patients compared to NC.

CONCLUSION
These initial data suggest that 2D-CSI MR spectroscopy may be useful in the early detection of metabolic CNS changes in pain modulating brain regions that appears normal on conventional MRI in SLE patients and may suggest underlying cerebral dysfunction in SLE patients without clinical evidence of CNS manifestations.

KEYWORDS: Proton MR spectroscopy, systemic lupus erythematosus

Poster 31
Correlation between Gadolinium Enhancement and 1H-MR Spectroscopy in the Study of Brain Tumors

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PURPOSE
Proton magnetic resonance spectroscopy (1H-MRS) allows noninvasive evaluation of tumor metabolic profile and it is useful in the diagnosis of brain tumors. Critical point to obtain spectra is the correct voxel positioning in representative and solid portion of the tumor. Paramagnetic contrast may be useful in this task, but experimental data suggest that contrast can cause loss of the choline (Cho) signal (1). The aim of this study was to determine how the administration of the contrast affects Cho signal of brain tumors using our standard 1H-MRS and how this effect is related to gadolinium (Gd) concentration estimated by the T1 enhancement.

MATERIALS & METHODS
Thirteen patients with intracranial tumors were evaluated: 8 glioblastomas, 2 metastases, 1 astrocytoma, 1 primitive neuroectodermal tumor (PNET), and 1 oligodendroglioma. Patients underwent MRI and multivoxel 1H-MRS performed at 1.5 T, included axial T1-weighted imaging before and after the paramagnetic contrast injection. Multivoxel was performed covering the T2 abnormality of the tumor before and after Gd. Cho signal was quantified in units for both MRS acquisitions and the percentage variation ChoVAR was quantified according to equation. Maps of T1 were created to calculate the T1 enhancement to estimate Gd uptake.

RESULTS
We were able to measure Cho signal before and after Gd for total of 70 voxels located on tumor areas, and mean values were 542 ± 245 and 528 ± 241, respectively. A paired t-test did not find significant differences between both measures. We found mean ChoVAR of 1 ± 34% (ranging from -47% to 204). We could not reproduce the mean ChoVAR of -15% described in the literature (4, 5). Probably due to the different type of tumors, as we believed that it depends very much on the Gd uptake and distribution properties of the tissue. When we observed the individual ChoVAR for each voxel we found a large variation from negative to positive values. When looking at the ChoVAR as a function of T1 enhance-
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Poster 32

Evaluation of Visual Pathways in Glaucoma: A 3T Diffusion Tensor MR Imaging Study

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Purpose
To evaluate visual pathways by diffusion tensor imaging (DTI) in patients with glaucoma.

Materials & Methods
Twenty-four patients affected by glaucoma were enrolled longitudinally in the study. Visual field deficits were classified into five different stages. A total of 24 healthy volunteers, matched for age and sex were recruited as controls. Each subject underwent a conventional MR study of the brain. Thus, DTI was performed by using a 3 T magnet. Fractional anisotropy (FA) and mean diffusivity (MD) analysis were performed in optic nerves and optic radiations.

Results
A significant correlation between DTI values and clinical impairment was found. In particular, increased MD and decreased FA values were found in the optic nerves of glaucomatous subjects. No significant statistical differences were observed in optic radiation between patients and controls.

Conclusion
The ultrastructural alterations of both optic nerves and optic radiations might be in vivo and noninvasively demonstrated by DTI MR imaging in patients with glaucoma. These data may be of value for clinical staging and evaluation of treatment response in glaucomatous patients.

Key Words: Diffusion tensor imaging, glaucoma

Poster 33

Preliminary Data of 3D MR Spectroscopy-Guided Brain Biopsy to Differentiate Recurrent/Residual Brain Tumor versus Radiation Injury: Correlation with Histopathology

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Purpose
New contrast-enhancing lesions that arise on routine follow-up brain MR imaging at the site of a previously identified and treated primary intracranial neoplasm present a significant diagnostic dilemma. The primary goal of this prospective study is to evaluate the usefulness 3D-CSI magnetic resonance spectroscopy (3D-CSI MRS) in the evaluation of new contrast-enhancing lesions in patients previously treated with radiation for a brain neoplasm. We propose to determine if early changes in variables derived from these specific techniques can differentiate recurrent tumor from radiation injury and correlate our metabolic ratios with histopathology. The ability of this noninvasive method and measurement to separate tumor from radiation injury with high sensitivity and specificity at the identification of a suspicious contrast-enhancing lesion could help determine future treatment intervention.

Materials & Methods
The study includes 6 male patients (aged 21-63 years) previously treated for primary brain neoplasm (5/6) and brain metastasis (1/6) by any combination of chemotherapy/resection/radiotherapy. All patients had a radiation dosage of 60 Gy. Patients were included if they presented with a new contrast-enhancing lesion at the site or vicinity of the previously treated primary tumor on routine follow-up MRI. MR examinations were performed on a research 3T MR scanner (Philips Achieva MRI system) utilizing a head-SENSE phased-array coil. The MRI protocol included sagittal T1-weighted, axial T2-weighted, FLAIR, DWI, axial T1-weighted pre and postcontrast, T1-weighted postcontrast coronal and sagittal. 3D-CSI MRS (TE/TR 288/1228 ms, width 2000Hz, matrix size: 18 x 16 x 6 spatial resolution 10 x 10 x 12 mm, acquisition time = 12 min). Based on the metabolic ratios different regions were suggested to be representative of diagnosis and marked for stereotactic biopsy guidance. All patients had biopsy of the proposed regions before eventual resection of the remaining lesion. Histopathology was considered gold standard for final diagnosis and for correlation with the radiologic presurgical suggested diagnosis.

Results
Three of the six patients were suggested to have radiation injury based on the MRS findings. In two of the three patients histopathology confirmed radiation injury, in the third case all regions suggested for biopsy had histopathology of radiation injury but malignant glioma cells were present in the remaining resected specimen. In the three other cases, recurrent tumor in one, and a mixture of tumor cells and radiation injury in two were suggested based on metabolic ratios and confirmed by histopathology. The mean
Cho/Cr and Cho/NAA ratios were significantly higher in areas histopathology confirmed tumor recurrences compared to radiation injury: 6.02 vs 1.95 and 17.8 vs 1.2, respectively. A high lipid peak was present in areas of radiation injury in three cases.

**CONCLUSION**
Our initial data suggest that 3D MRS with calculation of metabolic ratios provide additional promising noninvasive information in discriminating radiation injury versus tumor recurrence and that our suggested diagnosis correlated well with histopathology and hence may in the future prove to contribute to earlier treatment interventions.

**KEY WORDS:** MR spectroscopy, radiation injury

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**Poster 34**

**Role of FIESTA Sequence in the Diagnosis of Intraventricular Neurocysticercosis**

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**PURPOSE**
Cysticercosis, an infection caused by the encysted larval stage of the tapeworm *Taenia solium*, is one of the most common parasitic diseases of the central nervous system in humans. Neuroimaging studies are usually abnormal, and the detection of the scolex is pathognomonic. Intraventricular cysticercal cysts constitute 7% to 20% of neurocysticercosis infections but intraventricular cysts are difficult to diagnose not invasively. Magnetic resonance (MR) imaging, with its multiplanar capability and excellent depiction of tissue contrast is an important tool in the assessment of intraventricular cystic lesions. Balanced steady state free precession (FIESTA) is routinely used in the evaluation of cerebellopontine angle lesions and middle and inner ear structures. The purpose of this study is to investigate the role of three-dimensional MR sequence (3D-FIESTA) in the evaluation of intraventricular neurocysticercosis.

**MATERIALS & METHODS**
A prospective study with MR examinations of 13 patients suspected of intraventricular neurocysticercosis were obtained on 1.5 T MR unit. The following criteria were evaluated in FIESTA sequence: ventricular size, presence or absence of intraventricular cysts, and presence or absence of scolex inside the intraventricular cystic lesions. Parameters for the 3D-FIESTA were TR 4.5, TE 1.5, a field of view of 220 mm, a matrix of 512 x 512, section thickness of 0.8 mm and 0.4 mm of spacing.

**RESULTS**
In 12 of 13 cases the ventricles were enlarged. The FIESTA sequence identified intraventricular cysts in six patients. In all of them it was possible to identify the intermediate signal intensity of its wall. The patients with intraventricular cysts presented scolex (a hypointense mural nodule) in half of the cases (n = 3). In seven cases no cystic lesion was identified, and the diagnosis of intraventricular neurocysticercosis was excluded.

**CONCLUSION**
The 3D-FIESTA sequence is an important tool in the diagnosis of intraventricular neurocysticercosis.

**REFERENCES**

**KEY WORDS:** Neurocysticercosis, FIESTA, MRI

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**Poster 35**

**Inner Ear Signals on MR Cisternography in Patients with a Vestibular Schwannoma: Pre and Postsurgical Evaluation**

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**PURPOSE**
Vestibular schwannomas (VSs) may cause significantly higher protein concentrations in the perilymph than cerebello-pontine angle meningiomas, with our previous research in VS patients showing that ipsilateral inner ear signals were decreased on MR cisternography (MRC). This study compared inner ear signals on pre and postsurgical MRC, and determined whether signal recovery was observed on postsurgical MRC.
**MATERIALS & METHODS**

We carried out a retrospective review of 16 consecutive patients with histologically verified VS (8 males and 8 females; 24-65 years old, mean age 45.3 years at the presurgical MRC; tumor size (maximum diameter) 12-55 mm, mean 29.9 mm), who underwent tumor removal via a suboccipital approach, and had both pre and postsurgical MRC using the same pulse sequences between January 1, 2000 to September 30, 2007. The average interval between tumor removal and postsurgical MRC was 421.4 days (18-1770 days). Exclusion criteria were bilateral VSs, enhancement or hemorrhage (obvious hyperintensity on T1-weighted images) in the inner ear, MRC with either a severe artifact overlapping the inner ear or an asymmetrical background signal, and no postsurgical MRCs using the same pulse sequences as the presurgical study. MR imaging was performed on 1.5 T imagers (Magnetom Vision, Siemens; Signa Horizon EchoSpeed, General Electric), using constructive interference in steady state (CISS) imaging, and fast imaging employing steady state acquisition (FIESTA), respectively (CISS imaging; 12, FIESTA; 4). We compared the signal intensity of the bilateral vestibules using a circular region of interest (ROI), and calculated the ratio of the affected (ipsilateral) vestibular signal to the contralateral signal (I/C index) on pre and postsurgical MRC.

**RESULTS**

In this group of patients with a VS, the I/C index on presurgical MRC (I/C_{pre}) was 0.53-0.98 (mean ± SD 0.75 ± 0.10), while the I/C index on postsurgical MRC (I/C_{post}) was 0.74-1.02 (mean ± SD 0.89 ± 0.08). The I/C_{post} was significantly higher than the I/C_{pre} (p < 0.01, Wilcoxon’s signed rank sum test). The I/C_{pre} and I/C_{post} of the patients with total or almost total tumor removal (TR patients) were 0.71 ± 0.06 and 0.92 ± 0.02, while these values in patients with partial removal (PR patients) were 0.73 ± 0.02 and 0.85 ± 0.07, respectively. The signal recovery (I/C_{post} - I/C_{pre}) of the TR patients was significantly higher than that of PR patients (p 0.05, Mann-Whitney U-test).

**CONCLUSION**

In VS patients, decreased inner ear signals on MRC were improved after tumor removal, which may indicate decreased protein concentrations in the perilymph.

**KEY WORDS:** Vestibular schwannoma, MR cisternography, inner ear

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**Poster 36**

**Assessment of Gliomas after Radiation Therapy with Diffusion-Weighted MR Imaging and Proton MR Spectroscopy**

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**PURPOSE**

To assess the response of gliomas to radiation therapy using diffusion-weighted MR imaging and proton MR spectroscopy.

**MATERIALS & METHODS**

Diffusion-weighted MR imaging and proton MR spectroscopy were done for 45 patients (19M, 14F aged 48-67 yeareas: mean 55years) with pathologically proved gliomas after complete course of radiation therapy. Follow up was done for 19 patients. Diffusion MR imaging was done using a single-shot echo-planar imaging (EPI) with a diffusion-weighted factor, factor b of 0.500 and 1000 sec/mm². The apparent diffusion coefficient (ADC) map was reconstructed with calculation of the ADC values. Proton MR spectroscopy was performed using PRESS technique with assignment of the resonance peaks. The final diagnosis was established by histopathology (n = 29) or clinical course combined with imaging findings (n = 16). The calculated ADC values and metabolites signals and ratios correlated with the final diagnosis.

**RESULTS**

The difference in ADC value between responder and nonresponder brain tumors was statistically significant (p < 0.005). Nonresponder residual tumors showed higher choline (p < 0.003) and lactate (p < 0.03). The mean Choline/creatine ratio was significantly higher in nonresponder tumors (P < 0.004) with overlap in N-acetyl-aspartate/creatine ratio (P < 0.08) between responder and nonresponder tumors. The mean ADC values was correlated with Choline/creatine ratio (r = 0.93). On follow-up study, responder to radiotherapy shows significant increased in ADC value (P < 0.05) and decreased in Choline/creatine ratio (p < 0.002).

**CONCLUSION**

We concluded that combination of apparent diffusion coefficient value and metabolic markers of proton MR spectroscopy may provide an early surrogate marker for therapeutic efficacy of radiation therapy. So, they serve to follow up and monitoring of patients with gliomas after radiotherapy.

**KEY WORDS:** Diffusion weighted, MR spectroscopy, neoplasm
DSC Perfusion MR Imaging and Vascular Morphology Characteristics of C+ and C- Regions in Patients with Newly Diagnosed Glioblastoma Multiforme

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PURPOSE
Dynamic susceptibility-weighted contrast-enhanced perfusion MR imaging (DSC pMRI) is a noninvasive imaging tool to quantify hemodynamic alterations within brain tumors. Glioblastoma multiforme (GBM) vasculature can be categorized into the following histopathologic subtypes: glomeruloid, simple hyperplasia, and delicate vasculature. The aim of this study was to evaluate whether the histopathologic assessment of GBM cellularity, vascular morphology, and corresponding DSC pMRI characteristics differ between contrast-enhancing (C+) and nonenhancing (C-) regions.

MATERIALS & METHODS
Biopsies from 14 patients with newly diagnosed GBM were obtained using the image-guided stereotactic biopsy technique (IGSB). Using research software by GE, maximum and average relative cerebral blood volume (rCBV) and relative cerebral blood flow (rCBF) within IGSB regions of interest (ROIs) were measured. The pMRI ROIs were roughly the same size as the actual biopsy specimens (<2mm^3). Each biopsy specimen was subjected to identical collection and preservation processes. Histologic analysis of IGSB tissue, performed by a blinded neuropathologist, consisted of H&E staining, immunohistochemical staining for MIB-1 (cellular proliferation marker), and Factor-VIII (marker of microvascular cells). Based on these stains, morphologic features of tumor microvasculature were assessed then categorized: glomeruloid (complex microvascular hyperplasia), simple hyperplasia (increased endothelial cellularity with definitive lumen), and delicate (normal) vasculature. Each category of tumor vasculature was graded 0 (absent), 1 (present), or 2 (abundant). For continuous and ordinal variables, the Wilcoxon Rank-Sum test was used to determine differences between C+ and C- regions. For the histologic variables with two outcome categories, the Fisher’s exact test was employed to assess association between grades and contrast status.

RESULTS
The median MIB-1 was significantly higher in C+ region than C- region (p=0.05). Our data also suggest a larger variation among observations from C+ region in rCBV, rCBF and MIB-1 (Fig). The distributions of simple hyperplasia and delicate vasculature differ significantly between C+ and C- areas (respective p-values 0.03 and 0.02). Specifically, C+ regions are associated with higher simple hyperplasia while the C-regions found to have higher delicate vessels.

CONCLUSION
Our preliminary study shows that within IGSB regions obtained from patients with GBM, differences in perfusion characteristics, distribution of microvasculature subtypes, and degree of tumor cellularity exist between C+ and C- regions. Although our small sample size warns against overinterpretation, preliminary results suggest there may be important biological differences between C+ and C- regions that perfusion and histopathology can inform us on. Prospective studies with larger sample size and survival analysis currently are being conducted.

KEY WORDS: Perfusion MRI, vascular morphology, glioblastoma multiforme

Contrast-Enhanced MR Neuroimaging Protocols at 1.5 T and 3 T: Results of an Expert Consensus Panel

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PURPOSE
To develop state-of-the-art contrast-enhanced MR neuroimaging protocols that are optimized for the specific examination being performed and the field strength being used.

MATERIALS & METHODS
A multi-institutional panel of expert neuroradiologists was convened to evaluate and discuss MR neuroimaging protocols at 1.5 and 3 T. All participants used 1.5 T as well as 3 T machines in their research and clinical practice. Together, the experts developed protocols for commonly performed studies (whole brain, spine, neurovascular, acute stroke, and multiple sclerosis) as well as for several more specialized indications (IAC and cranial nerve, orbits, pituitary, and seizures). For each technical parameters (i.e., FOV, TR, TE, ETL, NEX, etc.), an absolute value or range of values was specified. Each protocol also included a recommended slice.
thickness and gap, plane(s) of reconstruction, and notes on any special sequences (IR, fat saturation, magnetization transfer) the group felt should be recommended or discouraged. In the absence of a complete consensus on a particular exam, annotations captured possible variations on approaches suggested by the panel. All recommended protocols subsequently were tested and further optimized as necessary prior to finalization.

RESULTS
Optimized neuroimaging protocols which are applicable at multiple institutions were developed and will be presented. Protocols at 3 T were optimized to take advantage of the high SNR provided by these systems while considering SAR issues. For the majority of contrast-enhanced MR examinations, a standard dose of 0.1 mmol/kg bodyweight is recommended; however, this dose may be reduced with the use of a high-relaxivity contrast agent. For certain exams at 1.5 T (e.g., pituitary lesions and acoustic neuromas) and for many studies performed on a 3 T scanner, a half dose of 0.05 mmol/kg bodyweight was felt to be adequate, particularly when a higher-relaxivity contrast agent was used.

CONCLUSION
Neuroimaging protocols should be optimized for the type of examination being performed and for the coil and field strength of the scanner being used. The use of high-relaxivity contrast agents may provide optimal enhancement at the lowest possible dose, maximizing contrast enhancement and patient safety.

KEY WORDS: MRI, imaging protocols, contrast media

Poster 39
Grading of Gliomas: Assessment with Diffusion-Weighted MR Imaging and Proton MR Spectroscopy

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PURPOSE
To evaluate the usefulness of apparent diffusion coefficient map and multivoxel proton MR spectroscopy in grading of gliomas.

MATERIALS & METHODS
This study included 48 patients (36 M, 12 F aged 57-69 years: mean 61 years) with gliomas underwent routine MR, diffusion-weighted MR imaging and MR spectroscopy. Diffusion MR imaging was done using echoplanar imaging. Proton MR spectroscopy was performed using multivoxel chemical shift imaging (CSI) with TE = 135. Apparent diffusion coefficient (ADC) values were determined in the solid part of the tumor and the peritumoral hyperintense area on T2-WI. We analyzed the spectral peaks and calculated ratio for lactate/creatinine, choline/Cr, NAA/Cr. Neuropathologic grading of patients was performed according to established WHO criteria: low grade (WHO I,II) and high grade (WHO III and IV).

RESULTS
Histologic grading were grade II astrocytoma (n = 7), grade III anaplastic astrocytoma (n = 13) and grade IV glioblastoma multiforme (n = 28). The mean ADC value of solid part of high-grade glioma was statistically lower (p < 0.001) than low-grade glioma. Peritumoral ADCs were statistically higher (p < 0.01) in low-grade than high-grade glioma. Proton MR spectra of high-grade gliomas showed significantly lower level of myoinositol and presence of lipid compared with that of low-grade gliomas. There was statistical difference in lactate/Cr ratio (p < 0.002) and insignificant difference of choline/Cr and NAA/Cr ratio (p < 0.6) between high- and low-grade gliomas.

CONCLUSION
Apparent diffusion coefficient map and MR spectroscopy are noninvasive imaging modalities that provide valuable information for preoperative grading of gliomas.

KEY WORDS: Glioma, diffusion, MR spectroscopy

Poster 40
Differentiating Brain Abscess from Cystic or Necrotic Tumor with Diffusion-Weighted MR Imaging and Proton MR Spectroscopy

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PURPOSE
To evaluate the role of diffusion MR imaging and MR spectroscopy in differentiating brain abscess from cystic or necrotic tumor.

MATERIALS & METHODS
Twenty-five patients (18 M, 7 F aged 12-72 years: mean 44 years) with ring-enhanced cerebral lesions on contrast-enhanced T1-weighted image underwent diffusion MR imaging (DWI) and proton MR spectroscopy on 1.5 T MR unit. Diffusion MR-weighted imaging was done using a single-shot echo-planar imaging with a diffusion-weighted factor b of 0.500 and 1000 sec/mm2. The apparent diffusion coefficient (ADC) map was reconstructed. Proton MR spectroscopy was performed using multivoxel chemical shift imaging (CSI). The acquisition parameters were: TR = 3000 msec, TE = 135 msec, 160 mm FOV, slice thickness of 10 mm and 2 averages. Images at b = 1000 sec/mm2, the ADC maps with ADC values and metabolites in proton MR spectroscopy were studied.

RESULTS
All abscess cavities showed hyperintensity on images at b = 1000 sec/mm2 and hypointensity on ADC map. The cystic or necrotic portion of the tumor showed hypointensity on images at b = 1000 sec/mm2 and hyperintensity on ADC map. Lactate with variable levels of lipids was seen in the necrotic or cystic part of the tumor. The solid part of glioma (n = 10) showed elevated choline, reduced NAA and creatine signals and variable levels of lactate. The solid part of metastasis (n = 4) showed high levels of myoinositol and absent NAA. Spectra from pyogenic abscess (n = 8) exhibited sig-
nals from lactate, acetate, succinate that may be associated with amino acids. Tuberculous abscess (n = 3) showed all metabolite levels with lipid resonance reduced.

**Conclusion**
We concluded that diffusion-weighted MR imaging may be useful as noninvasive excellent imaging modality in differentiating abscess from cystic or necrotic tumor. Proton MR spectroscopy produced noninvasive biological markers that can discriminate ring-enhancing cerebral lesions and enable therapeutic strategies to target the lesion.

**Key Words:** Diffusion, MR spectroscopy, abscess

**Poster 41**
**Involvement of White Matter Tracts Adjacent to Intracranial Tumors: Diffusion Tensor Imaging/Tractography Study**

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**Purpose**
1. To study the involvement of the corticospinal tract (CST) adjacent to intracranial tumors using DTI/tractography, and its correlation to sensorimotor deficits; 2. To evaluate on DTI/tractography the dissemination of gliomas to the contralateral hemisphere through white matter tracts [corpus callosum (CC) and anterior commissure (AC)].

**Materials & Methods**
Seventeen patients with pathologically proved intracranial tumors (11 gliomas, three metastasis, three meningiomas), eight having sensorimotor deficits (seven with hemiparesia), and five healthy controls. 3 T MRI (Philips, Achieva) including 3D-FFE (TR=6.6; TE=3.1; 256x40, 170 slices), and DTI (b=800; 16 directions; 60 slices). Using Philips postprocessing software (1), ROIs of the precentral gyrus and posterior limb of the internal capsule (IC) were drawn on two repeated occasions (same observer), FA and ADC values were calculated, and patients’ values were compared to controls. Also, whole tract CST quantitative DTI was performed, and number of fibers per Voxel (FPv), mean diffusivity (MD) and FA were calculated (2). Values of the affected hemisphere were compared to those of the nonaffected (subject’s t-test, significance p<0.05). DTI was related to MRI findings, to evaluate CST involvement by tumor and/or edema, and to sensorimotor deficits. Tumor dissemination to the contralateral hemisphere through the CC and/or AC were assessed additionally on DTI.

**Results**
Compared to controls, seven patients with gliomas had altered CST on DTI (six having sensorimotor involvement), and T2-hyperintensity on MRI (four involving the precentral gyrus and three the IC). Of those four gliomas having normal CST on DTI (three without any sensorimotor disturbance), none had hyperintensity on T2 in the precentral gyrus, two had hyperintensity and two mass effect on the IC. One patient with metastasis had altered CST on DTI, hyperintensity in the precentral gyrus suggesting edema, and hemiparesia. None of the three patients with meningiomas had altered CST on DTI, any signal change on MRI (one had only mass effect on the IC), or hemiparesia. Six patients with gliomas had involvement of the CC on DTI and MRI, and one of the AC. In patients with gliomas, only decreased FA values in the affected compared to the nonaffected hemisphere approached significance (0.50±0.04 vs 0.052±0.03; p=0.09) on whole tract quantitative DTI. In patients with intracranial tumors and sensorimotor deficits, there was significantly increased MD in the affected CST compared to the nonaffected (0.94±0.08 vs 0.84±0.076; p=0.006).

**Conclusion**
DTI detects alterations in the CST in patients with intracranial tumors. There are changes in FA and ADC values, with asymmetry between both hemispheres in the CST of patients having sensorimotor deficits, and in gliomas with increased signal intensity involving the CST on MRI. DTI allows visualization of the integrity of the CC and AC.

**References**

**Key Words:** Neoplasms, DTI, corticospinal tract

**Poster 42**
**Perfusion MR Imaging: Does It Beat Pathology?**

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**Purpose**
To investigate the efficiency of perfusion MRI in discrimination of high- and low-grade gliomas, as a complementary method to biopsy and surgery. We compared baseline relative cerebral blood volume (rCBV) with histopathologic tumor grading and clinical behavior in order to provide a second reference standard in the management of gliomas.

**Materials & Methods**
Dynamic susceptibility contrast images and determinations of maximal rCBV were performed in 78 subjects with histopathologically confirmed diffuse gliomas. Tumors were divided according to the WHO 2007 classification of tumors of the central nervous system into low- (grade II) and high-grade (grade III-IV) lesions. To avoid potential diagnostic error with biopsy samples, clinical behavior also was considered. Those tumors showing progression at one-year follow up despite a pathologic diagnosis of low grade were reclassified into high-grade tumors. Comparison of rCBV between high- and low-grade gliomas was obtained, considering separately the histologic diagnosis and the histologic diagnosis corrected by clinical follow up. The mean values
of rCBV were compared by means of the student’s t-test. Differences were considered significant for a $p < 0.05$. Correlation also was established between rCBV values and the presence of each of the histopathologic criteria for malignancy (mitoses, microvascular proliferation and necrosis).

**RESULTS**

When tumors were classified according to histologic criteria alone, mean rCBV was $3.80 \pm 1.69$ for high-grade and $2.26 \pm 1.47$ for low-grade tumors. This difference was significant ($p = 0.002$). When the clinical behavior also was considered for the diagnosis of low- vs high-grade gliomas, the difference was even greater, with a rCBV value of $3.73 \pm 1.7$ for high-grade vs $1.73 \pm 0.86$ for low-grade lesions ($p < 0.001$). Relative CBV values were $3.25$ and $2.17$ for tumors with and without mitoses respectively ($p = 0.11$), $3.67$ and $2.33$ for tumors with and without microvascular proliferation ($p = 0.01$), and $3.53$ and $2.62$ for tumors with and without necrosis ($p = 0.09$).

**CONCLUSION**

Relative CBV values significantly correlate with tumor grade in diffuse gliomas. In fact, high rCBV values in tumors histologically classified as low-grade lesions can help to predict an aggressive clinical course. Perfusion MRI could help to avoid undergrading, a problem of histologic diagnosis that has been attributed to the heterogeneity of gliomas, the small amount of tissue of some biopsies, and the interobserver variability of histopathologic criteria. A close correlation between rCBV and microvascular proliferation also was found, as it could be theoretically predicted. Regardless, a trend to higher rCBV values was found for the presence of necrosis and mitoses, the association between this histologic criteria and perfusion MRI results was not significant. High rCBV values closely correlate with malignancy in gliomas, and perfusion MRI may be a very helpful tool in decision making to manage gliomas, particularly in those that are classified pathologically as low grade but have some other aggressive features.

**KEY WORDS:** Brain tumors, perfusion MRI

**Poster 43**

**Differentiation between Classic and Atypical Meningiomas Using Diffusion Tensor Imaging**

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**PURPOSE**

Differentiating between classic and atypical meningiomas may have implications in preoperative planning but may not possibly based on conventional MRI. Our hypothesis was that classic and atypical meningiomas have different intratumoral water diffusion patterns that allow to preoperatively distinguish between them.

**MATERIALS & METHODS**

Preoperative diffusion tensor imaging (DTI) was performed in 12 classic and 12 atypical meningiomas. Signal intensity of solid-enhancing tumor regions on diffusion-weighted (DW) trace images, ADC and FA maps was assessed. Regions-of-interest were placed in solid-enhancing regions, peritumoral edema and contralateral normal-appearing white matter to measure tensor metrics including major ($\lambda_1$), intermediate ($\lambda_2$) and minor eigenvalues ($\lambda_3$) and FA and ADC values. Distribution of tensor shapes within enhancing tumors was calculated for all tumors. Differences between classic and atypical meningiomas in tumor signal intensity, intratumoral and peritumoral tensor metrics, as well as tensor shapes distribution were analyzed statistically.

**RESULTS**

Significantly greater proportion of atypical meningiomas were isointense and hypointense on ADC maps ($P = .007$). Classic meningiomas had significantly lower FA ($P = .012$), greater $\lambda_2$ ($P = .020$), $\lambda_3$ ($P = .003$) and ADC ($P = .011$). There was significantly more spherical diffusion in classic than in atypical meningiomas ($P = .020$). All diffusion tensor metrics for peritumoral edema of the two tumor groups did not differ.

**CONCLUSION**

Diffusion tensor imaging showed that intratumoral microscopic water motion is less organized in classic than in atypical meningiomas. This feature allows for noninvasive differentiation between classic and atypical meningiomas.

**KEY WORDS:** Meningioma, diffusion tensor imaging

**Poster 44**

**Conventional MR Imaging of Cerebral Gliomas: Interobserver Reliability of Simple Qualitative and Quantitative Parameters**

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**PURPOSE**

Cerebral glioma is associated with poor prognosis. Current imaging relies on qualitative assessment of anatomical MRI. Much glioma research focuses on novel MR modalities such as diffusion and perfusion imaging, and spectroscopy. These techniques have not yet found widespread clinical use, and rely on additional radiologist and technician training and expertise, additional software, specialized hardware, and additional scanning time. Volumetrics, qualitative tumor homogeneity, and tumor edge characteristics on conventional MRI have been assessed for their clinical utility and may yet yield additional diagnostic, prognostic and treatment response information (1-3). This only will be the case if they are reliably and easily measurable. This work aims to assess the interobserver reproducibility of simple volumetric and tumor edge characteristic assessment methods utilizing non-expert staff, standard computing equipment and open source analysis software.

**MATERIALS & METHODS**

For volumetric assessment, 28 patients with 29 cerebral gliomas (18 WHO grade IV, 12 grade II; two synchronous) were imaged on a Philips Achieva 3T scanner. Routine imaging consisted of pre and postgadolinium contrast T1-weighted images. Independent, blinded analysis was conducted by
two radiology residents (GT and JRC). Using MRcro, regions of interest were circumscribed on each slice and amalgamated into volumes of interest (VOI). Tumor volume (V_{TC}) was measured from the VOI on postcontrast T1-weighted imaging. Enhancing volume (V_{E}) was derived through semiautomated grayscale thresholding of the same VOI. Tumor edge characteristics were assessed on 24 tumors from the same cohort. Tumor border sharpness coefficient (TBSC) was measured in ImageJ on contrast-enhanced T1-weighted imaging using the method of Aghi (4). Dichotomous subjective assessment of tumor border regularity, sharpness and internal homogeneity also was performed. For interobserver agreement of continuous variables, the method of Altman and Bland and the intraclass correlation coefficient (ICC) were used, categorical data being assessed using Cohen’s kappa analysis.

RESULTS

Values are shown in the table. Graphical analysis of interobserver difference showed that approaching 95% of cases were within the 95% limits of agreement. No interobserver bias was observed in the continuous variable measurements. The ICC was ≥ 0.941 for objective quantitative measures (p < 0.001), unity representing perfect agreement. Cohen’s kappa was > 0.7 for each dichotomous subjective variable.

Interobserver Agreement of Select Volumetric, Edge and Homogeneity Characteristics in Glioma

<table>
<thead>
<tr>
<th>Parameter</th>
<th>n</th>
<th>% in 95% Limits of Agreement</th>
<th>Correlation Statistic</th>
<th>Confidence Interval</th>
<th>p value</th>
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<td>95.7</td>
<td>ICC 0.941</td>
<td>0.618 to 0.972</td>
<td>&lt;0.001</td>
<td>None</td>
</tr>
<tr>
<td>V_{E}</td>
<td>29</td>
<td>92.6</td>
<td>ICC 0.957</td>
<td>0.912 to 0.990</td>
<td>&lt;0.001</td>
<td>None</td>
</tr>
<tr>
<td>TBSC</td>
<td>24</td>
<td>97.5</td>
<td>ICC 0.950</td>
<td>0.849 to 0.978</td>
<td>&lt;0.001</td>
<td>None</td>
</tr>
<tr>
<td>Heterogeneity</td>
<td>24</td>
<td>-</td>
<td>kappa 0.750</td>
<td>0.463 to 1.015</td>
<td>&lt;0.001</td>
<td>-</td>
</tr>
<tr>
<td>T1 Border Sharpness</td>
<td>24</td>
<td>-</td>
<td>kappa 0.750</td>
<td>0.485 to 1.015</td>
<td>&lt;0.001</td>
<td>-</td>
</tr>
<tr>
<td>T1 Border Regularity</td>
<td>24</td>
<td>-</td>
<td>kappa 0.915</td>
<td>0.753 to 1.078</td>
<td>&lt;0.001</td>
<td>-</td>
</tr>
</tbody>
</table>

CONCLUSION

These data show an acceptable interobserver reproducibility for tumor volumetric, heterogeneity and edge characteristics using a simple method, employing open source analysis software on standard computing platforms. Volumetric measurement and edge characteristics also can be assessed on T2-weighted imaging (including measurements of edema volume). This method is suitable for future work assessing the relationship between conventional MRI tumor parameters and diagnostic and outcome data.

REFERENCES


KEY WORDS: Glioma, MRI, parametrics
RESULTS

Five out of six subependymomas were discovered incidentally in the lateral ventricle and measured less than 2 cm in maximal dimension. These were hyperintense to gray matter on FLAIR/T2-weighted images, isointense/slightly hypointense to gray matter on precontrast T1-weighted images and no enhancement on postcontrast T1 images. The sixth patient presented with gait disturbance, headache, nausea and vomiting and had a large left lateral and third ventricle mass, with heterogeneous signal intensity on all pulse sequences and areas of ring enhancement on postcontrast T1 images.

CONCLUSION

Subependymomas are not uncommon in the supratentorial compartment and should be considered in the differential diagnosis of intraventricular masses. Our poster will illustrate imaging features that should help in the diagnosis of this often asymptomatic lesion.

REFERENCES


KEY WORDS: Subependymoma, MRI, intraventricular
RESULTS
A significant improvement in SNR was noted in more peripherally located areas of the brain with the 32CH coil, such as the anterior forceps on the axial GRE (p=0.002), despite the two-fold reduction in scan time. The improvement in SNR lessened in more centrally located regions, such as the pons. In terms of SNR, the three scan techniques (with the 32CH) ranked 2D GRE > 2D BLADE turboFLASH > 3D FLASH regardless of ROI placement. In patient scans using the 32CH coil, despite a more than two-fold reduction in SNR when compared to the 2D GRE scan, the 2D BLADE turboFLASH scan was superior for lesion conspicuity in some instances due to reduced motion artifacts. This occurred despite the very short acquisition times (1:14 and 0:58 min:sec) possible for the 2D GRE scan due to use of the 32CH.

CONCLUSION
This investigation demonstrated a statistically significant improvement in SNR in more peripherally located regions of the brain using the prototype 32CH, despite a two-fold reduction in scan time, using standard T1-weighted 2D GRE scans. The 32CH coil also enabled high quality imaging using T1-weighted 2D BLADE turboFLASH and 3D FLASH scan techniques, which are otherwise impractical due to scan time for the BLADE acquisition and inadvertent patient motion due to prolonged scan times for the 3D FLASH acquisition.

KEY WORDS: 32-channel, 3 T, turboflash

Poster 49

Computer-Assisted Diagnosis and Detection of Intracranial Hemorrhage Using Adaptive Thresholding and Automated Anatomical Labeling

Xu, Q. · Ding, Z. · Creasy, J. L.
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Nashville, TN

PURPOSE
Intracranial hemorrhage (ICH) is diagnosed clinically by experienced radiologists, who review brain images acquired with x-ray computed tomography (CT). To aid the nonexperienced reader we previously have developed a computer algorithm to detect ICH regions automatically based on their CT number and anatomical location (1). This poster describes the extension of these methods to include software that will automatically label the site of candidate hemorrhage for further rule-based lesion classification.

MATERIALS & METHODS
The previously developed software to detect ICH included steps to segment and remove the bone; use adaptive thresholding that varied by location in the brain and closeness to the skull, the vertex, or the skull base; and detect bone in adjacent slices to compensate for bone averaging. The new software to anatomically label the site of hemorrhage begins by automatically registering the patient’s CT images to a constructed template with predefined brain anatomy. (1) Offline construction of template. The CT brain scans of 10 healthy volunteers are aligned and averaged to generate a template using automated image registration [AIR 5.2.5, (2)]. The standard Talairach space of the resulting template is defined by the anterior commissure, posterior commissure and the midsagittal plane, which are manually located by neuroanatomy experts. The anatomy of each voxel in the template is labeled according to their Talairach coordinate and the corresponding index in the data base of Talairach Daemon Client (3). (2) Online recognition of brain anatomy. Prior to registration, the approximate position of the lateral ventricles is computed to assist in correcting possible shifts of brain midline due to serious trauma. The corrected brain images then are registered to the constructed template, and resulting transform is used to map each voxel of the patient’s CT images to a point in the template, which has an associated anatomical label.
RESULTS
We applied the method to 20 patients with ICH, and have gained promising results. The initial hemorrhage detection software labels potential areas of intraparenchymal, intra-ventricular, and extra-axial hemorrhage. The shift correction software together with our transformational linkage between our candidate studies, our summated normal, and the online Talairach atlas allows the labeling of specific anatomical regions - despite distortions and shifts from large extra-axial hemorrhages.

CONCLUSION
In addition to our existing hemorrhage detection software, a robust method has been developed to automatically label the anatomy of a brain CT scan using image registration. Future work will be focused on generating rules for hemorrhage that take into account the anatomical location of candidate lesions.

REFERENCES
1. Qing Xu, Zhaohua Ding, Creasy JL. ASNR, 2007
2. Woods RP et al. JCAT 1998;22:139-152

KEY WORDS: Hemorrhage, computer assisted, anatomy

Poster 50
Neuroanatomy of Anxiety in Normal Volunteers: A Voxel-Based Morphometry Study

Moses, C. K. 1 · Wood, J. N. 2 · de Simone, V. 3 · Grafman, J. 1 · Spampinato, M. V. 1
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PURPOSE
A neural network including the amygdala, temporal and prefrontal lobes plays a key role in the expression of fear and anxiety. Our goal was to evaluate the relationship between regional gray matter volume of the neuroanatomical circuit of anxiety and self-reported levels of anxiety measured by the State-Trait Anxiety Inventory (STAI) using voxel-based morphometry (VBM) in a population of healthy volunteers.

MATERIALS & METHODS
High-resolution structural MR images were obtained on a 3 T scanner for 30 healthy right-handed subjects (mean age 28 years +/- 5.6 SD, 16 males). Self-report state (STAI-S) and trait anxiety (STAI-T) questionnaires were completed by subjects. The VBM analysis was carried out using the optimized procedure in SPM2 (Wellcome Department of Cognitive Neurology, London) (1), in order to obtain smoothed modulated normalized GM partitions for each subject. These images were entered into multiple regression analyses with STAI-S and STAI-T as covariates of interest in order to determine the brain regions whose volume varied with anxiety measures across subjects. Total GM volumes were entered into the multiple regression analysis, in order to control for global differences in intracranial volume that could affect the correct interpretation of regional GM morphometry. A conjunction analysis was performed in SPM2 to detect morphometric changes in GM which were correlated with trait and state anxiety measures. Results were thresholded at p-value < 0.001 (extent threshold = 50 contiguous voxels).

RESULTS
Mean STAI-S score was 29.4 (SD 9.1) and mean STAI-T score was 29.1 (SD 6.83). Results on each scale were not statistically different between genders. Measures of total GM volume were not correlated either with STAI-S (Pearson correlation coefficient, p-value = 0.280) or with STAI -T (Pearson correlation coefficient, p-value = 0.477). Significant negative correlations were observed between anxiety measures and GM volume in the dorsolateral prefrontal cortex bilaterally, in the rostral divisions of anterior limbic and prefrontal regions and in the left parahippocampal and left amygdala.

CONCLUSION
Self-report anxiety measures in healthy volunteers showed an inverse correlation with GM volume in regions of the limbic and prefrontal cortex. Previous studies have shown that these same areas are structurally and functionally altered in anxiety disorders. Volumetric and structural variability in limbic and prefrontal regions may have a correlation with the development of an anxious personality trait.

REFERENCES

KEY WORDS: Voxel-based morphometry, normal volunteers, anxiety

Poster 51
Utility of Multivoxel 1H MRS in Severe Traumatic Brain Injury

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Madrid, SPAIN

PURPOSE
To establish the relationship between different brain metabolites measured with 1H-MRS at the subacute traumatic period in several brain areas and the outcome of patients suffering severe traumatic brain injury (TBI). To determine which brain areas provide better information regarding the outcome of these patients when studied with 1H MRS.

MATERIALS & METHODS
1H-MRS was performed in 45 patients suffering severe head injury in the subacute period (median time after injury = 22 days). Multivoxel technique was used (PRESS). Measurements were obtained from subcortical occipital white matter, basal ganglia, thalamus and splenium of the corpus callosum. Clinical (age, admission GCS, motor GCS) and radiologic (initial CT findings, conventional MR findings) data related to outcome were collected. Outcome was established at discharge and at least 6 months after TBI by means of the Glasgow Outcome Scale (GOS). The relation between the different metabolic measurements or coeffi-
cients and initial severity of TBI and outcome was determined by using simple correlations and nonparametric tests (Mann-Whitney U test). The outcome discriminatory capacity obtained by the study of each brain area was established with the area under the receiver operating curve (AUC) of logistic regression models obtained for each measurement dichotomizing outcome into good and poor outcome.

RESULTS
A decrease of the NAA/Cr and NAA/CHO ratio and an increase in the CHO/Cr ratio are related to a worse prognosis. These metabolic disturbances are found more frequently in the splenium. In this area the discriminatory capacity for the NAA/CHO ratio (AUC=0.83) is highest for the NAA/CHO ratio. Metabolic parameters are independent of the initial severity of the injury measured with the GCS or the motor subscore of the GCS.

CONCLUSION
The splenium of the corpus callosum seems to be the most useful brain area in spectroscopy MR studies in patients suffering severe TBI. Metabolic disturbance caused by severe TBI and related to outcome in these patients are related to neuronal disruption or loss (NAA decrease) and glial proliferation (increase in CHO).

KEY WORDS: Trauma, spectroscopy, brain injury

Poster 52
3D MRS Imaging of Traumatic Brain Injury Patients at 3 T
Xu, D.1 · Veeraraghavan, S.1 · Zhao, Q.1 · Lee, H.1 · Meeker, M. R.1 · Lu, Y.1 · Ghajar, J.2 · Vigneron, D. B.1 · Mukherjee, P.1
1University of California San Francisco, San Francisco, CA, 2Brain Trauma Foundation, New York, NY

PURPOSE
Traumatic brain injuries (TBI) are suffered by approximately 1.4 million Americans each year, leading to 50,000 deaths, 235,000 hospitalizations, and over $60 billion dollars of medical costs and lost productivity according to CDC. Conventional MRI does not accurately predict outcome in TBI; proton MR spectroscopy has shown promise as a potential biomarker for injury severity and long-term neurocognitive and functional outcome. In this study, we utilized 3D MRSI at 3T with wide anatomical coverage to assess TBI, including serial examinations during the first year after mild TBI.

MATERIALS & METHODS
Five patients with moderate to severe TBI (GCS<13), 28 patients with mild TBI (GCS 13-15), six leg injury control subjects, and nine healthy volunteers were scanned on GE 3T scanner equipped with 8-channel receive coil. Control subjects and volunteers were age- and gender-matched to TBI patients. All patients had witnessed loss of consciousness and posttraumatic amnesia. Moderate-severe TBI patients were scanned more than 1 month after injury (1 month to 19 months). Twenty mild TBI patients were scanned serially within 2 weeks of injury, at 1 month, and 1 year; eight patients had initial scans but no serial studies.

Protocol included T2-FLAIR, T2*-MPGR, and 3D T1 SPGR. A 9.5-minute 3D MRSI was acquired using PRESS with TE/TR 144ms/1.1s, 12x12x8, 1cc resolution with reduced k-space sampling. Spectra were processed and analyzed using methods previously published (1). NAA/Cho ratios from the patient and control groups across all MRSI voxels were compared using the t-test. Longitudinal scans of the mild TBI patients were analyzed using linear mixed effects model fit by maximum likelihood for repeated measures.

RESULTS
Leg injury control group and healthy volunteer group showed no statistically significant difference and were combined in comparisons with the TBI patient groups. NAA/Cho ratios were 1.55±0.14, 1.87±0.41, and 1.94±0.51, respectively, for moderate-severe TBI, mild TBI (within 2 weeks of injury), and control subjects. Moderate-severe TBI patients demonstrated significant differences of NAA/Cho versus mild TBI patients and control subjects with P<<0.01. Mild TBI patients showed a trend of decreased NAA/Cho versus control group at all three time points of within 2 weeks, 1 month, and 1 year; however, this did not reach statistical significance (P=0.17). For mild TBI serial study, NAA/Cho ratios were 1.90±0.36(2 weeks), 1.89±0.37(1 month), 1.86±0.38(1 year). Examined longitudinally, NAA/Cho ratio did not show any significance when initial scans were compared to 1 month (P=0.95) and 1 year (P=0.48), and 1 month to 1 year (P=0.53). Also, the overall trend over the entire 1-year period did not reach statistical significance (P=0.14).

CONCLUSION
These results confirm previous reports of decreased NAA/Cho ratio, specifically a decrease in NAA following TBI (2-3). In the mild TBI group, the decrease of NAA/Cho did not reach statistical significance due to variability between subjects. Future work will correlate this variability to neurocognitive and functional outcome measures to validate MRSI as a biomarker for mild TBI.

REFERENCES

KEY WORDS: TBI, MRSI, 3 T

Poster 53
Utility of Ultrasound Imaging in Ocular Emergencies
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1Boston University Medical Center, Boston, MA, 2Baylor School of Medicine, Houston, TX

PURPOSE
Ultrasound has been utilized in ophthalmology departments for the diagnosis and management of acute, sight-threatening ocular emergencies. In most ophthalmic institutions an ultrasound examination is conducted to evaluate the integrity of the posterior segment when the retina cannot be visualized by direct ophthalmoscopy. We present various cases that elucidate the pivotal role of ultrasound in the diagnosis and management of ocular emergencies.
Posters

**Materials & Methods**
We reviewed ultrasound examinations of patients seen in the acute setting to identify the variety of ocular emergencies that could be characterized by ultrasound. When available other imaging modalities such as CT scans, obtained at the time of the ocular emergency, also were reviewed. Ultrasound examination findings were correlated to surgical time of the ocular emergency, also were reviewed. Other imaging modalities such as CT scans, obtained at the time of the ocular emergency, also were reviewed. Ultrasound was found to demonstrate both high sensitivity and specificity when identifying retinal detachments, vitreous hemorrhage, and penetrating traumas with intraocular foreign objects. Ultrasound examination findings were well correlated to surgical findings. It was shown that bedside ultrasound exams decreased the morbidity associated with penetrating intraocular injuries and assisted in providing an expedited and accurate assessment of optimal treatment options.

**Conclusion**
Ultrasound is a quick and reliable method of demonstrating abnormalities in the posterior segment, and is useful in acute ocular emergencies.

**Key Words:** Ocular trauma, retinal detachment, vitreous hemorrhage

**Poster 54**
**Evaluating Carotid Stenosis with 64-Slice CT Angiography: Superior Anatomy Demonstration and Safety Profile when Compared to Catheter Angiography and MR Angiography**

Mahadevia, S.1 · Miller, T. S.1 · Nolan, T.2 · Gross, M.3
1Montefiore Medical Center, Bronx, NY, 2Albert Einstein College of Medicine, Bronx, NY, 3Barnard College, New York, NY

**Purpose**
This study was performed to determine if 64-slice CTA demonstrates carotid artery stenosis as effectively as catheter angiography and MRA.

**Materials & Methods**
This is a retrospective review with Radiology Information System (RIB) approval. The Radiology Information System was queried to determine those patients who have had their carotid arteries evaluated with catheter angiography, CTA, or MRA. Three subsets of patients were identified; those who had all three modalities, or a combination of any two. NASCET criteria was used to measure carotid stenosis in these patients. All carotid CTA was performed on a 64-slice machine with 0.625 slice thickness, 10cc timing bolus, 40cc arterial bolus. All MRA was performed on a 3 T system without contrast. Catheter angiography was performed in a modern digital biplane suite. Measurements from cross-sectional datasets were made from images optimizing axial vessel diameters. On average catheter angiography utilized 80cc of contrast, and CTA utilized 50cc of contrast.

**Results**
There were no complications. Individual arterial stenoses, as measured on the three modalities, were similar for most patients. Those with the most severe stenoses demonstrated an overestimation on MRA. Arch anatomy was better demonstrated on biplane digital angiography than on other modalities. Intracranial collaterals were better demonstrated by catheter angiography. Carotid stenosis severity as determined with CTA was no different than that demonstrated by catheter angiography.

**Conclusion**
CT angiography acquired on a 64-slice machine provides a noninvasive yet adequate analysis of carotid stenosis, arch anatomy, and collateral circulation.

**Key Words:** Anatomy, carotid, CTA

**Poster 55**
**Visualization of the Superior Ophthalmic Veins by 3 T 3D Time of Flight MR Angiography**

Uchino, A.
Saitama Medical University, International Medical Center Hidaka, JAPAN

**Purpose**
The superior ophthalmic veins (SOVs) are sometimes visualized on three-dimensional time-of-flight magnetic resonance (3D-TOF-MR) angiograms obtained with a 3 T imager. The purpose of this retrospective study was to determine the incidence of visualization of normal SOVs on 3D-TOF-MR angiograms, as well as their characteristic features.

**Materials & Methods**
We reviewed 3D-TOF-MR angiograms of 345 consecutive patients obtained with a 3 T MR imager. Patients group comprised 170 males and 175 females, aged 5 to 93 years. Most of the patients had, or were thought to have, cerebrovascular disease.

**Results**
The SOV was visualized in 13 of the 345 patients (3.8%). In seven of the 13, the visualized SOV was on the left side, and in two, it was on the right side. In four patients, both the right and left SOVs were visualized; in two of these patients, the left SOV was more clearly visualized, and in the other two, the SOVs were equally visible on both sides. There was a female predominance (M:F = 1:12) but no relation between age and visualization of SOVs. None of the visualized SOVs were dilated, and no dilated cavernous sinus was seen. The facial veins and angular veins also were visualized, continuing to the SOVs, suggesting rapid retrograde flow in the facial veins.
Conclusion
Superior ophthalmic veins are sometimes visualized on 3D-TOF-MR angiograms. This phenomenon should not be misdiagnosed as an asymptomatic dural carotid-cavernous fistula.

Key Words: Superior ophthalmic vein, facial vein, MR angiography

Poster 56
Dual Energy Synchronous Digital Subtraction CT Angiography in Head and Neck with 64 MDCT

Liu, H. · Yang, C. · Lee, C. · Lu, C. · Chen, Y.
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Taipei, TAIWAN

Purpose
Introduce new methodology to perform automated bone subtraction CTA in the head and neck region.

Materials & Methods
Between October 2007 and December 2007, 15 patients (8 females and 7 males) were enrolled in this study. This study was done in the same operation console and workstation to process the bone subtraction. Synchronous subtraction was applied to minimize the possibility of motion artifact. This was successful due to manual control of the original starting point of the tube between the two sets of imaging before and after contrast medium injection. Another important factor was the controlling of the injection delay.

Results
Excellent results were shown in 80% of patient, fair image quality in 10%, and poor in 10% in routine platform. The poor images were due to motion artifact. Improvement can be obtained by additional and better head fixation. With dual energy protocol, the bone can be removed easily with just threshold algorithm. On the other hand, this method also can decrease the patient radiation dosage.

Conclusion
Dual energy synchronous digital subtraction CTA in head and neck with 64 MDCT can provide excellent no bone CTA in head neck region automatically.

Key Words: CT angiography, vessel, algorithm
MRA is useful for diagnosis and follow up of the RCVS; that the distribution of arterial changes is not restricted to small- and medium-sized arteries.

**KEY WORDS:** Cerebral arteries, stenosis, MRA

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**Poster 58**

**Utility of CT Perfusion with Acetazolamide Challenge to Assess Cerebrovascular Reserve in Adult Moyamoya Disease**

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¹University of Cincinnati Medical Center, Cincinnati, OH; ²Cincinnati Children’s Hospital Medical Center, Cincinnati, OH; ³Christ Hospital, Cincinnati, OH

**PURPOSE**

Moyamoya disease is a chronically progressive cerebrovascular disease affecting the supraclinoid internal carotid arteries with prominent collateral formation. Alterations of local cerebral hemodynamic status are important in understanding and planning treatments for patients with moyamoya disease. Also, cerebrovascular reserve testing has a key role in selecting these patients for revascularization surgery and for the guidance of graft placement. The purpose of the study was to assess the utility of CT perfusion in the evaluation of cerebral perfusion and cerebrovascular reserve with acetazolamide challenge in adult moyamoya patients.

**MATERIALS & METHODS**

Ten patients in the age range of 25-55 years with moyamoya disease, were evaluated with dynamic CT perfusion. CT perfusion was performed with dynamic axial imaging during bolus administration of 40 cc of contrast at an injection rate of 5 cc/sec followed by 40 cc of saline at 5 cc/sec. Two slices of 10 to 14 mm slice thickness were interrogated at the level of the basal ganglia and a higher adjacent slice. One thousand milligrams of acetazolamide was administered intravenously and repeat perfusion was performed after a delay of 15 minutes to assess the vasodilatory capacity. Quantitative and qualitative evaluation of the pre and postacetazolamide images was performed using cerebral blood volume (CBV), cerebral blood flow (CBF), mean transit time (MTT) and hemispheric ratios. Percentage increase in cerebral blood flow after acetazolamide administration was used to define the cerebrovascular reserve.

**RESULTS**

In all the studied patients, the flow maps were abnormal with slightly increased CBV, moderately decreased CBF with a corresponding increase in the MTT in the affected anterior cerebral artery (ACA) and middle cerebral artery (MCA) distributions. Hemodynamic compromise was worse in the ACA and ACA-MCA watershed distributions. There was augmentation of flow with no delay in MTT in the PCA territory, as this was the primary noncollateralized distribution in these patients. Cerebral vascular reserve in the cerebral cortex in the territories of the ACA and MCA was lower than that of the territory of the PCA and the central region of the basal ganglia. Four patients demonstrated negative vasodilator reactivity with decreased CBF after acetazolamide administration, suggesting steal phenomenon.

**CONCLUSION**

CT perfusion with acetazolamide challenge has promising use in the hemodynamic assessment and evaluation of vasodilatory capacity in patients with moyamoya disease.

**KEY WORDS:** CT perfusion, cerebrovascular reserve, moyamoya disease

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**Poster 59**

**Circadian Pattern of Intraarterial Therapy for Ischemic Stroke**

Pinedo, D. · Thrutchley, D. · Akhtar, N. · Rymer, M. M.
Saint Luke’s Brain and Stroke Institute
Kansas City, MO

**PURPOSE**

Studies have established a circadian pattern for the time of onset for ischemic stroke (IS) with a preponderance of strokes occurring during daytime hours, peaking in the morning between 06:00 and 11:59. As more intraarterial treatment (IAT) options for IS become available requiring specialized personnel and equipment, it is important to establish when those resources will be needed. We sought to review the experience of the Saint Luke’s Brain and Stroke Institute in regard to timing of IAT and the circadian pattern of stroke onset.

**MATERIALS & METHODS**

All ischemic stroke cases between 1/2000 and 7/2007 were reviewed for time of onset. Procedure start time was obtained for those cases that were evaluated for IAT with cerebral angiography (CA). Times were grouped into four 6-hour blocks: 00:00-05:59, 06:00-11:59, 12:00-17:59, 18:00-23:59.

**RESULTS**

Stroke onset occurred most frequently during daylight hours (69.2% of cases between 06:00-17:59) with a slightly higher incidence before noon than after noon. Cerebral angiography was performed most frequently between noon and 6pm (40.3% of cases). Intraarterial treatment occurred most frequently between noon and midnight (69.7% of cases). Cerebral angiography with negative findings (no clot found) occurred much more frequently during daylight hours (47.7% negative studies from 6am to noon and 33.6% from noon to 6pm).

**Time Blocks**

<table>
<thead>
<tr>
<th>Time Blocks</th>
<th>Stroke Onset</th>
<th>CA Start Time</th>
<th>IAT</th>
<th>No Clot Found</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00-05:59</td>
<td>117 (8.0%)</td>
<td>91 (14.3%)</td>
<td>77 (17.3%)</td>
<td>14 (15.4%)</td>
</tr>
<tr>
<td>06:00-11:59</td>
<td>523 (35.9%)</td>
<td>111 (17.5%)</td>
<td>58 (13.0%)</td>
<td>53 (47.7%)</td>
</tr>
<tr>
<td>12:00-17:59</td>
<td>485 (33.3%)</td>
<td>256 (40.3%)</td>
<td>170 (38.1%)</td>
<td>86 (33.6%)</td>
</tr>
<tr>
<td>18:00-23:59</td>
<td>331 (22.7%)</td>
<td>177 (27.9%)</td>
<td>141 (31.6%)</td>
<td>36 (20.3%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1456</strong></td>
<td><strong>635</strong></td>
<td><strong>446</strong></td>
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</tbody>
</table>

**CONCLUSION**

The purpose of the study was to establish when those resources will be needed. We sought to review the experience of the Saint Luke’s Brain and Stroke Institute in regard to timing of IAT and the circadian pattern of stroke onset.

**KEY WORDS:** IS, cerebral angiography, IAT, circadian pattern

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**Poster 60**

**Circadian Pattern of Intraarterial Therapy for Ischemic Stroke**

Pinedo, D. · Thrutchley, D. · Akhtar, N. · Rymer, M. M.
Saint Luke’s Brain and Stroke Institute
Kansas City, MO

**PURPOSE**

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**MATERIALS & METHODS**

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</table>

**CONCLUSION**

The purpose of the study was to establish when those resources will be needed. We sought to review the experience of the Saint Luke’s Brain and Stroke Institute in regard to timing of IAT and the circadian pattern of stroke onset.

**KEY WORDS:** IS, cerebral angiography, IAT, circadian pattern
CONCLUSION
The preponderance of daylight stroke onset times in our series reflects what has been reported previously. Personnel and equipment for IAT were used around the clock with the highest volume of cases occurring between noon and midnight. Case selection for CA resulting in IAT was more accurate between 6pm and 6am than between 6am and 6pm. The significant percentage of angiograms and therapies performed between 18:00 and 06:00 indicates a considerable out-of-hour workload for neurointerventionalists.

KEY WORDS: Stroke, thrombolysis

Poster 60
Intracranial Hypotension: A Pictorial Essay and Review of the Literature

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PURPOSE
To describe the imaging features of spontaneous intracranial hypotension using contrast-enhanced magnetic resonance imaging (MRI).

MATERIALS & METHODS
Intracranial hypotension is a syndrome characterized by postural headaches and CSF hypovolemia. Most cases are secondary to a tear in the dura mater following lumbar puncture with resultant CSF leak and volume depletion; however, it also can occur secondary to severe dehydration and in many cases no cause is identified when it is termed “spontaneous”.

RESULTS
In this poster we highlight the salient MRI features of this unusual condition, which include thick linear enhancement of the pachymeninges, elongation and descent of the midbrain, subdural effusions and enlargement of the pituitary gland. In addition we review the existing literature, proposed pathogenesis and treatment of this condition.

CONCLUSION
Intracranial hypotension as a single pathophysiologic entity is rare but well described in the literature. It is important to be aware of the MR imaging characteristics of this condition to be able to make an early and confident diagnosis.

KEY WORDS: Intracranial, hypotension, spontaneous

Poster 61
Using “CT Angiography Protocol” to Evaluate the Dural Venous Sinuses on Multidetector CT

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PURPOSE
CT venography (CTV) is quickly becoming the radiologists’ workhorse for diagnosing dural venous sinus thrombosis. It is free of the flow-related artifacts which plague MR venography (MRV) and the complications which hamper traditional angiography. However, it comes with significant radiation for patients, particularly when it is performed in conjunction with CT angiography (CTA). In this study, we examine whether the dural venous sinuses are displayed adequately using CTA technique, such that both studies could be accomplished with no additional radiation to the patient.

MATERIALS & METHODS
This is a retrospective study evaluating dural venous sinus opacification in 100 consecutive CTA cases performed over the past 2 years. Each case is evaluated by two neuroradiologists to determine the adequacy of opacification of the dural venous sinuses. These results are correlated with the timing parameters for contrast injection and image acquisition, in order to determine acceptable scanning parameters for evaluating dural venous sinus thrombosis. All cases were performed on a 40- or 64-detector CT scanner.

RESULTS
Our experience using CTA protocol to evaluate the dural venous sinuses is presented. Our current protocol allows adequate opacification of the dural sinuses in most patients. Prior studies have nicely defined optimal dural venous sinus imaging using 16-detector speed (2). As scanning speed increases, these parameters must be reevaluated, including timing of contrast injection and image acquisition.

CONCLUSION
We present our experience using a CTA protocol to evaluate the dural venous sinuses. This study is an early step in finding a balance between radiation risks and optimal venous opacification when formulating imaging protocols for diagnosing dural venous sinus thrombosis with multidetector CT (MDCT).

REFERENCES
Poster 62

Value of Sinus Angioplasty as the First-Line Therapeutic Option for Pseudotumor Cerebri with Sinus Outlet Obstruction

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PURPOSE
To evaluate the value of sinus angioplasty in the treatment of patients with pseudotumor cerebri and venous hypertension.

MATERIALS & METHODS
A total of three young and pediatric patients, two males and one female, presented with acute visual loss. Angiograms showed sinus occlusion and stasis of contrast material, with an increased pressure gradient in the venous system. We used venous sinus angioplasty as the first therapeutic option. The entire procedure was done under general anesthesia and heparinization.

RESULTS
The postangioplasty angiogram revealed well patent of venous outflow tract and the pressure gradient was decreased. This treatment method was effective, and symptoms and signs of all three patients subsided quickly within 3 days. The follow-up period ranged from 3 months to 1 year, under stable clinical conditions. No procedure-related complication was noted.

CONCLUSION
In our initial and limited experience, sinus balloon angioplasty appeared to be an appropriate first-line treatment for patients with pseudotumor cerebri, sinus outlet obstruction, and acute vision loss. We prefer to use sinus stent placement as a second-line option when initial attempts are unsuccessful, especially in pediatric and young adult patients.

KEY WORDS: Pseudotumor cerebri, venous sinus obstruction, venous angioplasty

Poster 63

Hemorrhage in Posterior Reversible Encephalopathy Syndrome

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Pittsburgh, PA

PURPOSE
Hemorrhage in posterior reversible encephalopathy syndrome (PRES) has been reported. In this study, we investigated the CT/MR imaging appearance of hemorrhage in a large PRES population and evaluated relevant associated clinical features. The purpose of this study is to describe the incidence, imaging patterns and clinical findings in intracranial hemorrhage associated with PRES.

MATERIALS & METHODS
In a retrospective review of 152 patients with PRES, 23 patients demonstrated evidence of intracranial hemorrhage on CT/MR imaging. Characteristics of the hemorrhage were tabulated including CT/MR imaging features and location. Clinical features were assessed including toxicity presentation, clinical associations, toxicity blood pressure (BP), coagulations, BP stability, and subsequent BP management.

RESULTS
Hemorrhage was identified in 23 of 152 (15%) PRES patients with variable associations including: transplantation/tacrolimus (10), infection/sepsis/shock (6), autoimmune condition (3), chemotherapy (1), eclampsia (1), and idiopathic (2). Six patients had only microscopic foci of hemorrhage, seven had one or more focal hematomas, six had only sulcal hemorrhage, three had both a hematoma and microscopic hemorrages, one had both sulcal hemorrhage and a hematoma. Eight patients (35%) were normotensive at toxicity (MAP <106 mmHg), four (18%) were mildly hypertensive (MAP: 106-115 mmHg), and 11 (48%) had significant hypertension (MAP ≥ 116 mmHg). Of the six patients with sulcal hemorrhage, two were normotensive and four were significantly hypertensive. Of the seven patients with a focal hematoma, two were normotensive, two were mildly hypertensive, and three had significant hypertension. There was an even distribution of BP’s among patients with “microhemorrhages”.

CONCLUSION
Hemorrhage is not uncommon in PRES (15%) and the imaging appearance can be subtle. Recognized patterns (small foci, focal hematomas, and sulcal subarachnoid hemorrhage) were of similar frequency and mixed patterns were observed. Hemorrhage was commonly identified in normotensive (35%) and mildly hypertensive (18%) patients. This observation raises many questions regarding the mechanism of hemorrhage in PRES.

KEY WORDS: Posterior reversible encephalopathy, brain hemorrhage, encephalopathy hypertensive
**Poster 64**

64-Slice CT Cerebral Perfusion Evaluation in Patients with Carotid Artery Stenosis before and after Stenting with Cerebral Protection Device

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Rome, ITALY

**PURPOSE**

Aim of the study was to evaluate by 64-slice-CT examination (VCT) the cerebral perfusion modifications in patients with severe carotid stenosis before and after carotid artery stenting with a cerebral protection system.

**MATERIALS & METHODS**

Fifteen patients with unilateral symptomatic stenosis (≥70%) underwent perfusional CT (PVCT) 5 days before and 1 week after the stenting procedure. Cerebral blood flow (CBF) and mean transit time (MTT) values were measured.

**RESULTS**

Increased MTT and decreased CBF values were observed in the cerebral areas supplied by the stenotic cerebral artery as compared to the cerebral areas supplied by the contralateral patent artery (P < 0.001). A significant normalization of the perfusion parameters was observed after the stenting procedure (mean pretreatment MTT value: 5.3 ± 0.18; mean post-treatment MTT value 4.3 ± 0.17, p < 0.001; mean pretreatment CBF value 41.2 ml/s ± 2.0; mean posttreatment CBF value 47.9 ml/s ± 2.94, p < 0.001).

**CONCLUSION**

Perfusional CT is a useful technique for the assessment of the hemodynamic modifications in patients with severe carotid stenosis. The quantitative evaluation of cerebral perfusion makes it a reliable tool for the follow up of patients who undergo carotid stenting.

**KEY WORDS:** VCT brain perfusion after carotid stenting

**Poster 65**

Use of a New Intracranial Guide Catheter to Facilitate Posterior Circulation Neurovascular Intervention

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**PURPOSE**

Indications for intracranial neurovascular intervention have expanded. Our ability to treat cerebrovascular lesions is improved by our ability to limit the distance from the guide catheter to the target lesion. We report the use of a new guide catheter, which allows for intracranial access, the Neuron guide catheter (Penumbra, Inc., San Leandro, CA, USA), in the treatment a basilar artery aneurysm.

**MATERIALS & METHODS**

A 65-year-old male was found to have an unruptured basilar apex aneurysm. To treat this with endovascular techniques, we exchanged the diagnostic catheter and sheath for a 7F x 35 cm femoral sheath and the 6F Neuron catheter. This was navigated to the V3-V4 junction (Fig 1). We then used a microcatheter and microwire through the intracranial access catheter to access and coil embolize the bi-lobed basilar apex aneurysm. Final angiography was performed showing complete occlusion and no injury related to catheter position (Fig 2).

**RESULTS**

Our case involved a bi-lobed basilar artery aneurysm. We felt that having more distal access in the vertebral artery would improve microcatheter stability. This allowed us to completely pack the aneurysm with coils. In addition, the flexible distal zone was able to easily navigate through the vertebral artery to the V3-V4 segment without damage to the vessel.
**CONCLUSION**
This case illustrates that this intracranial access catheter can be used safely and effectively for the treatment of a basilar apex aneurysm.

**KEY WORDS:** Intracranial guide catheter, posterior circulation, endovascular treatment

**Poster 66**

**Increased Intravascular Diffusion-Weighted Signal in Five Patients with Dural Venous Thrombosis**

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**PURPOSE**
The diagnosis of dural venous thrombosis is often difficult. Nonspecific symptoms, including headache, nausea, vomiting, and seizures, frequently do not prompt the clinician to suspect the diagnosis. As a result, only standard MR sequences may be ordered, without thrombosis-specific sequences such as MR venography or 3D MPRAGE. On routine imaging, venous thrombosis may produce signal that overlaps with brain parenchyma on T1 imaging, and may be mistaken for flow voids on T2 imaging. In fact, our experience suggests that the diffusion-weighted imaging (DWI) sequence may provide the most prominent evidence for dural venous thrombosis on some routine MRI exams. On DWI, intense signal localized to one or more dural sinuses may signify dural venous thrombosis.

**MATERIALS & METHODS**
Initial MRI studies were reviewed retrospectively in five patients found to have imaging findings of dural venous thrombosis between 2005 and 2006. Four of the five patients eventually were evaluated with MR venography in addition to T1, T2, FLAIR, and DWI sequences. The fifth patient was evaluated without MRV. Available MR sequences were evaluated for findings suggesting dural venous thrombosis. In particular, DWI sequences were evaluated for restriction diffusion within cortical veins and dural sinuses. Diffusion-weighted imaging abnormalities were correlated with areas of thrombosis seen on MRV.

**RESULTS**
In two patients with sagittal sinus thrombosis, markedly reduced diffusion was seen in an intravascular distribution identical to areas of thrombus identified on MRV. Two additional patients demonstrated DWI abnormalities that raised suspicion for, but did not correlate exactly with areas of thrombus visualized on MRV: one patient with sagittal and transverse sinus thrombosis showed restricted diffusion only in the sagittal sinus, and one patient with sagittal sinus thrombosis demonstrated DWI abnormality in cortical veins. In a fifth patient (without MRV) suspected of having transverse sinus thrombosis based on areas of high T1 and T2 signal, matching areas of moderately increased DWI signal were seen.

**CONCLUSION**
Dural sinus thrombosis is a cryptic diagnosis which may not be identified on T1 and T2 sequences. Awareness of the often striking intravascular DWI increased signal changes that may be associated with dural venous thrombosis may considerably increase our sensitivity to the disease when initially it is not suspected.

**KEY WORDS:** Dural venous thrombosis, sinus thrombosis, diffusion-weighted imaging

**Poster 67**

**Association of Cerebral White Matter Periarterial Hyperintensities with Periventricular Parenchymal and Deep Gray Matter Periarterial Hyperintensities in Hypertensive Patients: A 3T MRI Study Using Balanced Steady-State Free-Precession Imaging**

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**PURPOSE**
This study aimed to investigate relationship of periarterial hyperintensities (PAH) in the cerebral white matter with periventricular parenchymal hyperintensities (PVH) and PAH in the deep gray matter in patients with arterial hypertension.

**MATERIALS & METHODS**
Using 3 T MRI (Trio, Siemens, 12-channel head coil), a prospective study was performed in patients with severe hypertension (having hypertension-caused, small-artery stroke) and hypertension-only and in nonhypertension controls (Table 1). All subjects underwent axial T1w, FLAIR, and T2*w images, and axial and coronal T2w (0.21×0.21×5.0 and 0.22×0.22×5.0 mm, respectively; 2 average) and 3D balanced steady-state free precession (bSSFP) (0.20×0.20×2.5 and 0.23×0.23×3.0 mm, respectively; 3 average) images. PAH number on axial T2w and bSSFP image and PVH area on FLAIR image were assessed in the various cerebral white matter regions (Fig. A). In the deep gray matter, region of interest and histogram analysis was performed in the putamen (y=−4 mm, from the anterior commissure), globus pallidus (y=−4 mm), middle thalamus (y=−20 mm) and posterior thalamus (y=−24 mm). PAH area was determined based on signal intensities of the lower internal capsule (Fig. B).

**RESULTS**
On bSSFP images, PAH was more clearly identified (Fig. C). In all cerebral white matter regions, PAH number was independent of clinical variables and significantly higher in severe hypertension. In the deep gray matter, only putamen showed a greater PAH area (Fig. D). In the anterior and posterior cerebral white matter regions, PAH number was correlated with PVH area (Table 2). Putaminal PAH area was correlated with PAH number in all regions.
Table 1. Subjects Baseline Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Severe Hypertension</th>
<th>Hypertension Only</th>
<th>Non-hypertension</th>
<th>p value</th>
</tr>
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<tbody>
<tr>
<td>Number</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Age, y (SD)</td>
<td>61.2 (11.1)</td>
<td>61.9 (9.9)</td>
<td>61.4 (5.4)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Gender, man %</td>
<td>100</td>
<td>100</td>
<td>80</td>
<td>&gt;0.05</td>
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<tr>
<td>Ethnicity, white %</td>
<td>90.0</td>
<td>100</td>
<td>80.0</td>
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<tr>
<td>Diabetes mellitus %</td>
<td>20.0</td>
<td>10.0</td>
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<td>&gt;0.05</td>
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<td>Smoking history, %</td>
<td>60.0</td>
<td>60.0</td>
<td>30.0</td>
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<tr>
<td>Antihypertensive medication, %</td>
<td>100*</td>
<td>100†</td>
<td>0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Mean blood pressure, mmHg (SD)</td>
<td></td>
<td></td>
<td></td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Anterior</td>
<td>96.7 (10.6)</td>
<td>99.2 (8.0)</td>
<td>92.4 (11.9)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Middle</td>
<td>88.1 (15.6-144.0)</td>
<td>54.8 (8.0-109.8)</td>
<td>54.7 (12.6-117.0)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Posterior</td>
<td>111.1 (6.9-361.8)</td>
<td>13.9 (0-139.8)</td>
<td>11.3 (0-117.3)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Lacunar infarcts, n (range)</td>
<td>1.5 (0-5)§</td>
<td>0</td>
<td>0</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Microbleeds, n (range)</td>
<td>2 (0-9)§,#</td>
<td>0</td>
<td>0</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

+ *, †, ‡, §; P<0.001, 0.01, 0.05, respectively, compared to nonhypertension. ¶, #; P<0.001, 0.05, respectively, compared to hypertension-only.

Table 2. Results of Correlation Analysis

<table>
<thead>
<tr>
<th></th>
<th>Cerebral white matter PVH area r P value</th>
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</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>0.38</td>
</tr>
<tr>
<td>Posterior</td>
<td>0.61</td>
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</tbody>
</table>

Deep gray matter PAH in:

<table>
<thead>
<tr>
<th></th>
<th>Cerebral white matter Deep gray matter r P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>0.41</td>
</tr>
<tr>
<td>Posterior</td>
<td>0.54</td>
</tr>
</tbody>
</table>

Conclusion

Probably due to T2/T1 contrast, bSSFP image identified PAH in cases with parenchymal hyperintensities. In hypertensive patients, severe PAH in the cerebral white matter, seen on clinical T2w MRI, may be related to the presence of white matter disease and be an independent etiologic marker of small-artery stroke.

Key Words: Perivascular space, MRI, hypertension

Poster 68

Demonstration of Active Intracranial Hemorrhage from Saccular Aneurysm at CT Angiography

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We present a case of profuse bleeding from a middle cerebral artery aneurysm demonstrated by CTA. The contour of the aneurysm was irregular and there was extravasation of the contrast agent from the aneurysm into the hematoma which suggested active bleeding during CTA examination. Immediate diagnosis of cerebral aneurysms and there active bleeding shown by CTA are reliable radiologic findings which can activate urgent therapy. We think our case demonstrates the bleeding aneurysm distinctly and helps to understand imaging features of this potentially lethal condition.

Key Words: CT angiography, aneurysm, bleeding

Poster 69

MR Imaging Appearance of Complicated Migraine

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Purpose

Hypoperfusion of the malfunctioning brain region contralateral to the affected side of the body has been described on magnetic resonance imaging (MRI) in only a few patients with prolonged migrainous aura. We present one such case report.

Materials & Methods

A 35-year-old female with past history of headache off and on and no history of aura preceding it, presented with sudden onset of visual aura followed by loss of vision on left side. Following this she had nausea, vomiting and headache. MR imaging was performed at this stage. She got relief with symptomatic treatment. One month later she had a similar episode. MR imaging was performed again at this stage. Findings were documented, correlated with clinical manifestations and compared with other such cases reported in the literature.

Results

The first MRI scan revealed ill-defined lesions hypointense on T2-weighted FLAIR images, located in right temporal and right occipital region. Diffusion-weighted images revealed no abnormality. MR angiogram, T1-weighted and T2-weighted images were normal. Second MRI scan was performed approximately 20 days following the first MRI. It revealed similar lesions in right occipital lobe. Lesions in the right temporal lobe had resolved. Follow-up MRI performed 7 weeks later was normal.
CONCLUSION
A migrainous cerebral infarct has the appearance of an ischemic cerebral lesion. According to the “time is brain” concept, differential diagnosis of acute stroke and prolonged migrainous aura is of vital importance in this era of systemic thrombolysis for acute cerebral ischemia.

KEY WORDS: Migraine, MRI, ischemia

Poster 70
Clinical Usefulness of FLAIR for Evaluating Postoperative Alternation of Cerebral Hemodynamics following STA-MCA Anastomosis in Patients with Moyamoya Disease

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Nagasaki, JAPAN

PURPOSE
Leptomeningeal high signal intensity (LMHI: ivy sign) on fluid-attenuated inversion-recovery (FLAIR) image is one of the MR features of moyamoya disease. Its clinical significance, however, is not elucidated. Our purpose was to characterize LMHI on MR and to evaluate its role in the assessment of circulation through a surgically established bypass in moyamoya disease.

MATERIALS & METHODS
Twelve patients with angiographically confirmed moyamoya disease who underwent superficial temporal artery - middle cerebral artery (STA-MCA) anastomosis were included in the study. Findings on preoperative FLAIR images were compared with those on conventional angiography. The grade of LMHI on FLAIR images was classified as “absent”, “equivocal”, and “present”. Two neuroradiologists reviewed FLAIR images in separate sessions for the LMHI and assigned the grading by consensus. Nineteen hemispheres of 12 patients (5 patients had unilateral bypass surgery) were assessed for the frequency of visualization and distribution of LMHI. Postoperative FLAIR images were compared with SPECT in 16 hemispheres of 10 patients.

RESULTS
Equivocal and present LMHI was seen in 14 out of 19 hemispheres (74%). Leptomeningeal high signal intensity was seen more prominently in the frontal lobe than in parietal, temporal and occipital lobe. More prominent LMHI was observed in the hemispheres in which cortical branches of the middle cerebral arteries were poorly visualized on conventional angiography. After STA-MCA anastomosis, LMHI disappeared in 12 (63%) and decreased in 2 (11%) of 19 hemispheres. SPECT demonstrated hemodynamic improvement according to the area of revascularization, which matched with the area of disappeared or decreased LMHI.

CONCLUSION
Fluid-attenuated inversion-recovery image can show the cerebral hemodynamic alternation after STA-MCA anastomosis, and the disappearance of leptomeningeal high signal intensity (disappearance of ivy sign) is a useful sign in evaluating effectiveness of the surgery in moyamoya disease.

KEY WORDS: Moyamoya disease, FLAIR

Poster 71
Role of 16-Row CT Angiography in the Assessment of Intracranial Aneurysms: Comparison Between Imaging Data and Surgical Results. Two Years Experience

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Rome, ITALY

PURPOSE
To evaluate the accuracy of 3D CT angiography (CTA) in the preoperative assessment of intracranial aneurysms, comparing the imaging data with the intraoperative findings.

MATERIALS & METHODS
During 2 years we evaluated 72 consecutive patients harboring intracranial aneurysms, by CT angiography. Twenty-one of 72 patients (age range: 32 to 70 years) underwent surgery for the treatment of 27 aneurysms, ranging from 1 to 40 mm in diameter (n°16 < 10 mm, n° 11 > 10 mm). All patients were studied with a 16-row CT scanner (GE Lightspeed) by injecting 90 ml of iodinated contrast agent at 3 ml/sec; in each case MPR average and MIP, and 3D thick slab and whole brain VR images were generated. The imaging data were compared with the intraoperative movies, the still pictures and the reports of the neurosurgical procedure, jointly by a neuroradiologist and a neurosurgeon.

RESULTS
For the optimal matching of imaging and intraoperative findings we took into account the following features: regional vascular anatomy visualization, lesion identification, aneurysm location and morphology, relationship with surrounding structures and presence of vessels originating from the aneurysmal sac; because of the impossibility to obtain reliable intraoperative measurements we did not consider the...
aneurysm sizes. We reviewed the surgical reports, comparing at the same time the movies acquired during surgery and the source, the MIP and 3D CT images. To assess the accuracy of CT findings and the correspondence with surgical findings a score from 1 (no correspondence) to 3 (complete correspondence) was allotted for each of the above-indicated features. In our series we found complete overall correspondence (3) in 59.3% of cases, rising to 85.2% excluding the “relationship with surrounding structures” feature. In 7.4% the noncomplete correspondence was related to “lesion identification” feature. In the remaining 7.4% there was noncomplete or no correspondence at all between CTA and surgery.

CONCLUSION
CT angiography is able to provide useful preoperative evaluation of intracranial aneurysms; further improvements in CT technology and in postprocessing work up are needed to increase the accuracy of preoperative assessment and to better guide the surgical procedure.

KEY WORDS: Aneurysm, CT angiography, surgery

Poster 72

Brain Parenchymal Alterations in Cerebral Sinovenous Thrombosis Correlate with Venous Involvement and Thrombosis Extent

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1Cincinnati Children’s Hospital Medical Center, Cincinnati, OH, 2University of Cincinnati College of Medicine, Cincinnati, OH, 3The Neuroscience Institute, Cincinnati, OH

PURPOSE
Brain parenchymal alterations are a common sequelae of thrombosis of the cerebral veins and dural sinuses [cerebral sinovenous thrombosis (CSVT)]. Previous experimental models have noted a relationship between cortical venous thrombosis and brain parenchymal alterations (hemorrhage, edema, swelling). Little is documented regarding this relationship in humans. Modern imaging techniques (MRI, MRV, and CT venography) can detect cortical venous involvement. We undertook this study to assess whether involvement of the cortical veins and extent of thrombosis as documented on MRI, MRV, and CT venography correlates with brain parenchymal alterations in CSVT.

MATERIALS & METHODS
Cases of CSVT (birth - 80 years) were identified by searching radiology reports for the terms “cerebral venous thrombosis” and “dural sinus thrombosis” from 1/2000 until 9/2007 at both an adult and a pediatric tertiary care hospital. Seventy-one cases of CSVT were identified. Documentation of venous thrombosis was made by contrast-enhanced CT, CT venography, MRI with contrast, or MR venography. The presence of hemorrhage, edema, or swelling (without edema) was correlated with the extent of thrombosis (number and location of thrombosed venous segments).

RESULTS
Three hundred twenty thrombosed venous segments were identified in the study population (Superior sagittal sinus - 58, Sigmoid sinus - 54, Jugular bulb - 57, Internal jugular vein - 13, Straight sinus - 10, vein of Galen - 5, Internal cerebral veins - 5, Cortical veins - 21, Occipital sinus - 1). Parenchymal abnormalities were seen in 25 cases (35%). These included: Hemorrhage - 16, Edema - 21, Edema without hemorrhage - 4, and swelling (without edema) - 3. Parenchymal abnormalities were more common in those patients with venous thrombosis (cortical veins, vein of Galen, internal cerebral vein); 18/22, 81.2% than those with thrombosis only identified in the dural sinuses; 7/49, 14.3% (p < 0.0001). The mean number of thrombosed segments was greater in those patients with parenchymal abnormalities (5.6) than in those without (3.91) (p = 0.034).

CONCLUSION
In CSVT, brain edema and hemorrhage are more common when thrombosis involves the parenchymal venous structures than when thrombosis is limited to the dural sinuses. Parenchymal abnormalities are also more common with greater extent of thrombosis. This is probably secondary to locally increased venous pressure and lack of adequate collaterals when smaller venous tributaries are occluded or when venous thrombus burden is greater.

KEY WORDS: Cerebral venous thrombosis

Poster 73

MR Imaging, Diffusion-Weighted Imaging, Perfusion-Weighted Imaging and MR Angiography Study in Acute Ischemic Stroke Patients: Comparisons between rtPA Treated Patients and Controls

Marziali, S. · Gaudioello, F. · Garaci, F. G. · Meschini, A. · Melis, M. · Di Legge, S. · Ludvici, A. · Stanzione, P. · Floris, R. · Simonetti, G.
University of Rome Tor Vergata Rome, ITALY

PURPOSE
To evaluate the efficacy of IV rtPA treatment in acute stroke patients by clinical and MRI parameters compared to standard treatment.

MATERIALS & METHODS
Consecutive patients with acute stroke admitted to our Stroke Unit (SU) over 12 months. 3 T MRI and MR angiography (MRA) were performed on admission and after 5-7 days. Diffusion-weighted imaging (DWI) and perfusion-weighted imaging lesion volume was calculated in postprocessing and was evaluated for the presence of mismatch using cutoffs of 20%.

RESULTS
Eighty-three eligible patients were enrolled. The MRI was performed < 3 hours in 58 (70%) of patients. Forty-five patients received IV rtPA within 3 hours, 13 patients had contraindications to rtPA. RtPA-treated patients had shorter onset-to-MRI time (1 vs 1.8; p < 0.001), higher admission NIHSS (14 vs 9; p = 0.03), recanalization rate on MRA (8/9 vs 2/7; p = 0.02) compared to controls. In rtPA-treated patients we observed a significant reduction in discharge NIHSS score (p = 0.006), and only a mild increase in DWI
volume vs untreated patients. In controls discharge NIHSS did not significantly change, while a significant DWI lesion growth was observed (p = 0.02).

**CONCLUSION**

The clinical benefit from rtPA treatment is supported by mild and not statistically significant DWI lesion growth and higher recanalization rate compared to controls. Statistically significant DWI lesion growth and lack of clinical improvement as observed in untreated patients support the potential usefulness of MRI in selecting patients for rtPA treatment among those beyond the 3-hour window or with mild deficits. Analysis on a larger cohort is ongoing.

**KEY WORDS:** MRI DWI-PWI, acute stroke

**Poster 74**

**Comparison of Tmax, Mean Transit Time and Quantitative Cerebral Perfusion Using the Bookend Technique in Ischemic Stroke**

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**PURPOSE**

To compare and contrast MR-based indicators of tissue at risk of infarct using quantitative cerebral perfusion with more traditional approaches based on bolus dynamics: mean transit time (MTT) and Tmax.

**MATERIALS & METHODS**

The MR imaging of cerebral blood flow in acute stroke is normally based on imaging metrics related to bolus dynamics. Typically MTT or Tmax are used to identify region of “tissue at risk”. While these techniques have proved to be useful identifying the vascular distribution involved in a stroke, they often overestimate the degree of involvement. In this study we evaluate quantitative MR perfusion in its ability to distinguish between the core of an infarct, and the surrounding tissue that is within the affected vascular distribution but viable. A previously reported (1-3) imaging protocol was implemented and acquired in 10 stable acute stroke patients. All patients were scanned between 2 and 7 days postictus. Quantitative cerebral blood flow (qCBF) images of cerebral blood flow, as well as MTT and Tmax images were produced. Regions of interest were drawn on diffusion-weighted images (DWI) to cover core, contralateral normal tissue and the ipsilateral vascular distribution surrounding the core. ROC analysis was used to determine the diagnostic accuracy of the MTT, Tmax, and qCBF parameter to identify infarcted regions in white and gray matter. Sensitivity, specificity and area under the curve (AUC) are reported.

**RESULTS**

We found that Tmax and qCBF showed similar diagnostic accuracy in the region contralateral to a stroke, but that qCBF showed slightly higher accuracy when identifying hypoperfused, but viable tissue ipsilateral to an infarct. For gray matter the AUC was: 0.93 for qCBF, 0.95 for Tmax, and 0.87 for MTT. For white matter AUC see Fig 1. When comparing the ROC distribution for the area surrounding/adja-

cent to the core infarct, we saw that qCBF was able to give a better distinction for evaluating tissue at risk for cell death as compared to Tmax or MTT. The gray matter AUC for this was seen as 0.67 for qCBF, 0.60 for Tmax, and 0.52 for MTT. See Figure for the corresponding white matter results. Ischemic thresholds were calculated also.

**CONCLUSION**

Quantitative cerebral blood flow may have a better way of distinguishing adjacent tissue at risk for infarct surrounding the core infarct in the same vascular distribution.

**References**


**KEY WORDS:** Stroke, MR perfusion, cerebral blood flow

**Poster 75**

**Acute Ischemic Stroke Etiology: The Role of CT Angiography Integration**

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**PURPOSE**

CT angiography (CTA) is a noninvasive technique that is useful for rapid imaging of the large vessels of the neck, and first to second order arteries of the brain. The purpose of the study was to evaluate the benefit of incorporating CTA in the initial workup of ischemic stroke on determining the stroke subtype and mechanism.

**MATERIALS & METHODS**

We conducted a retrospective observational study that included all of the patients admitted to the neurological ward, in Soroka Medical Center, with the diagnosis of acute ischemic stroke or TIA during the period of February-March 2004-2006. We compared the patients admitted in 2004-2005, before CTA was in use, to those admitted in 2006, using CTA. We analyzed differences in demographics, clinical presentation, hospital work up, stroke subtype, proportion of etiological diagnoses, and acute and preventive therapy.
RESULTS
The study included 243 patients, 75 admitted during 2004, 81 during 2005 and 87 during 2006. Patients diagnosed with stroke were 88.1% (n = 214) and with TIA [transient ischemic attack] 11.9% (n = 29). Patients referred for CTA testing were younger (p < 0.0001), and included a higher proportion with decline in consciousness (p = 0.043), a higher rate of headache upon admission (p = 0.047), and a higher proportion of smokers (p = 0.043). On the other hand, those patients had a lower rate of hypertension (p = 0.026). There were no differences between the 2004-2005 group and the 2006 group in demographic characteristics or clinical presentation. However, the rate of etiological diagnoses was significantly higher in the 2006 group (p = 0.01). A logistic regression model found that performing a CTA increased the chances of reaching an etiological diagnosis by a factor of 7.1 (95%CI: 2.5-18.5).

CONCLUSION
Incorporating CTA within the initial work up of an ischemic stroke improved the quality of diagnosis and understanding of the mechanism of injury, thus allowing for more appropriate planning of the acute and long-term management. We conclude that CTA should be included as a part of the initial evaluation process of an acute ischemic stroke in selected patients.

KEY WORDS: Stroke, CTA

Poster 76
Utility of CT Perfusion in Ultra-Early Imaging of Acute Stroke
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PURPOSE
Until recently, the initial CT assessment of acute stroke patients has included a noncontrast study and possibly CT angiography. Perfusion is a relatively new CT imaging technique, useful in the physiologic determination of intracranial blood distribution, especially in cases of ischemia. We suggest that application of CT perfusion to the imaging armamentarium adds pivotal information to the diagnosis and characterization of patients presenting with acute stroke symptoms. Where possible, CT perfusion should be included in the imaging algorithm in acute stroke in both the tertiary and community settings.

MATERIALS & METHODS
A retrospective CT analysis of 38 consecutive patients presenting at a tertiary care acute stroke center within 3 hours of onset of acute stroke symptoms was conducted. Noncontrast CT, CT perfusion, and postcontrast CT were performed in all patients as part of the imaging protocol. CT angiography was also performed in 17 of the cases. Without clinical history, a neuroradiologist blinded to the CT perfusion findings randomly assessed the noncontrast studies for the presence or absence of parenchymal changes, size, and location of the abnormality. CT perfusion studies were similarly assessed and the results correlated. Postcontrast CT and CT angiograms were reviewed to determine if any additional information was ascertained. Follow-up noncontrast CT studies were used as the gold standard.

RESULTS
Noncontrast CT detected changes of acute infarction in 36.8% of cases. The addition of postcontrast CT added useful information in 28.9% of cases. CT angiography added information in 47.1% of cases in which it was performed. CT perfusion detected acute infarction in 81.6% of cases and provided additional information in all of those cases. Furthermore, in more than one third of patients, CT perfusion was the only CT imaging technique to provide the imaging diagnosis of acute ischemia.

CONCLUSION
CT perfusion can be a powerful imaging tool in the assessment of cerebral ischemia and should be included in the CT diagnostic algorithm in all patients presenting with acute stroke.

KEY WORDS: CT perfusion, stroke, ASPECTS

Poster 77
Early Experience with BLADE for Motion Correction and Effect on Lesion Characterization
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PURPOSE
Image degradation due to patient motion is a pervasive problem in MR imaging. The BLADE method of data collection and reconstruction samples k space with overlapping data strips in a radial fashion with each strip running through the center of k space. This redundancy in sampling then can be used to compare data strips for phase inconsistencies occurring as a result of in-plane patient motion, which then can be corrected. This method has been shown to improve detection of lesions on diffusion-weighted images (1). T2-weighted FLAIR and sagittal T1-weighted gradient-echo BLADE images also have been shown to be preferred over rectilinear counterparts when using 3 T magnets (2). In pediatric patients the similar PROPELLER sequence was found to improve image quality; however, improvement in lesion detection was not found (3). The purpose of this study was to compare axial BLADE T2-weighted fast spin-echo and FLAIR images and multiplanar T1-weighted images with their traditional rectilinear counterparts and assess differences in motion correction, image quality and preference, as well as the detection of lesions and adequacy of lesion characterization.

MATERIALS & METHODS
A registry of 70 pairs of BLADE and non-BLADE images was created. The images were randomized and reviewed independently by two neuroradiologists who rated the degree of motion artifact and adequacy of lesion characterization. Subsequently, the paired BLADE and non-BLADE
images were reviewed side by side and direct comparisons were made regarding image quality, lesion characterization, and overall preference.

RESULTS

Motion rating agreement between reader ICC = 0.88, which was statistically significant. Average motion rating non-BLADE 1.7 +/- 1.2, BLADE 1.5 +/- 0.87, statistical analysis with independent samples t-test and p value will be performed. Under direct comparison BLADE images were preferred 80% of cases reviewed. A chi-square test indicates that whether the sequence was BLADE or not predicted reader preference at a statistically significant level (chi2 = 8.0, df = 2, p = 0.018). Of the cases in which a lesion was detected but felt to be inadequately characterized 75% were non-BLAGE. Furthermore, whether characterization was adequate or not readers agreed that characterization was better with BLADE in every case. In one case a lesion was detected on BLADE images only; in no cases was the reverse true.

CONCLUSION

BLADE images demonstrated reduced motion artifact in our series. Agreement between readers, as well as reader preference for BLADE regarding overall image quality and lesion characterization was statistically significant. BLADE therefore may serve an important role in neuroimaging.

REFERENCES


KEY WORDS: Blade, motion artifact

Poster 78

Pseudo-Continuous Arterial Spin Labeling Imaging Findings in Clinical Patients with Normal Bolus Perfusion-Weighted Imaging

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PURPOSE

Bolus perfusion-weighted imaging (PWI) is a widely used technique for assessing the cerebrovasculature. Arterial spin labeling (ASL) is a noncontrast method of measuring CBF, which has not been extensively employed clinically. This study examines ASL imaging findings in patients with normal PWI scans.

MATERIALS & METHODS

Seventy-nine patients underwent routine clinical MR brain imaging at 1.5 T (GE) supplemented with ASL and bolus PWI. Arterial spin labeling (6 min) was performed using a pseudo-continuous, background-suppressed, 3D spiral FSE sequence (1) with 3 mm in-plane/4 mm through-plane resolution and labeling time/post-label delay of 1500/1500 ms. In 12 patients, PWI was standard single-shot GE (TR/TE=2000/60 ms). In the remaining 67 patients, PWI was performed using multiecho parallel imaging [R=3, TR/TE=1225/(13,30,43)] (2). CBV and Tmax maps were evaluated for abnormalities.

RESULTS

Thirty-four of the 79 patients (43%) had normal PWI studies (15 M, 19 F, age 63±17 years). Of these, 14 patients (41%) had normal ASL studies with symmetric parenchymal signal. Thirteen patients (38%) had varying degrees of bilateral MCA-ACA watershed region ASL signal dropout with surrounding serpiginous hyperintensity in the surrounding cortical regions (watershed sign); this may reflect decreased watershed CBF or prolonged arterial arrival time. The patients with normal ASL scans were younger than those with the watershed sign (51±15 years vs 70±15 years, p<0.01, respectively). In the remaining seven patients, there was a variety of different findings: posterior circulation ASL signal dropout with cortical hyperintensities (2); serpiginous high signal near small DWI positive lesions (2); asymmetric watershed sign (1); low ASL signal in small basal ganglia infarct (1); low ASL signal in cerebellar resection cavity (1).

CONCLUSION

Three-dimensional FSE pseudo-continuous ASL demonstrated a range of findings in patients with a normal bolus PWI study. Many ASL images were normal, but in a more
elderly population, watershed dropout of ASL signal was seen frequently. We believe this represents a combination of lower CBF and longer arterial arrival times in these patients. In theory, Tmax should be sensitive to the longer arrival times, but may have too coarse temporal resolution (> 1 s) to detect these changes. Longer postlabel delay times are likely required for clinical ASL studies if quantitative CBF information is required. However, the increased sensitivity of ASL to subtle hemodynamic abnormalities may select a subgroup of patients with poorer prognosis.

REFERENCES

KEY WORDS: Arterial spin labeling, MRI, cerebral blood flow

Poster 79

Comparison of Conventional Echo-Planar Imaging Diffusion-Weighted Imaging vs FSE BLADE (PROPELLER) Diffusion-Weighted Imaging for Evaluation of Acute Brain Infarction Using 12- and 32-Channel 3 T Head Coils

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PURPOSE
To compare diffusion-weighted imaging (DWI) based on fast spin-echo (FSE) sequences using BLADE (PROPELLER) with conventional DWI-EPI techniques at 3 T and to demonstrate the influence of hardware developments on SNR with these techniques using 12- and 32-channel head coils.

MATERIALS & METHODS
Four patients with acute brain infarcts were evaluated with DWI using both EPI and FSE BLADE sequences, with a 12-channel head coil, in both the axial plane and one additional plane (either sagittal or coronal). Signal to noise (SNR) and CNR were calculated from ROI measurements. Scans were evaluated in a blinded fashion by two senior neuroradiologists. Two additional patients were evaluated in a similar fashion, but comparing scans acquired with the standard 12-channel coil and an innovative 32-channel design. In addition, both DWI techniques were evaluated in 22 volunteer studies (12 axial, 10 coronal) using different parallel imaging factors (for the EPI sequence) and both the 12- and 32-channel coils.

RESULTS
Using DWI-BLADE with the 12-channel coil revealed a significant reduction in SNR (mean+/−/SD) of the lesions (7.0+/−/3.6), normal brain (4.2+/−/2.7) and subsequently in CNR (4.2+/−/2.6) as compared to the DWI-EPI sequence (SNR lesion (13.1+/−/7.3), SNR brain (11.0+/−/5.0), CNR (8.6+/−/4.0), p<0.001. Despite this reduction in SNR and CNR, the blinded read revealed a marked preference for the DWI-BLADE sequence, or equality between the sequences, in the majority of patients. Lesion detection often was degraded by susceptibility artifacts on axial DWI-PJ scans (Reader 1)/(Reader 2): (BLADE 0/14, EPI 2/14, none 12/14)/(BLADE 0/14, EPI 6/14, none 8/14). There was a marked preference for the DWI-BLADE sequence for lesion detection in the brainstem and cerebellum. On some DWI-BLADE scans, in the additional plane, lesion detection was degraded by radial-like artifacts. Comparison of scans obtained in patients with both the 12- and 32-channel coils revealed SNR and CNR to be equal or greater for the DWI-BLADE sequence (on the 32-channel coil) when compared to the DWI-EPI sequence using a parallel imaging factor of 2 (on the 12-channel coil). In volunteers, SNR was improved significantly using the 32-channel coil when compared to the 12-channel coil, irrespective of scan technique. Comparing DWI-EPI acquired with the 12-channel coil and a parallel imaging factor of 2 to DWI-BLADE acquired with the 32-channel coil, comparable SNR values were obtained. Use of a parallel imaging factor of 4 with the 32-channel coil in combination with the DWI-EPI sequence resulted in a further reduction of bulk susceptibility artifacts (as compared to an IPAT of 2), and also comparable SNR to the DWI-BLADE sequence performed with the 32-channel coil.

CONCLUSION
Despite lower SNR, DWI-BLADE sequences acquired using the currently available 12-channel coil are preferable in most instances, as compared to DWI-EPI sequences, due to the absence of susceptibility artifacts and improved depiction of lesions in the brainstem and cerebellum. With the 32-channel coil, recently FDA approved, DWI-BLADE provides comparable SNR to the DWI-EPI sequences currently acquired and has the potential to become the new gold standard DWI technique.

KEY WORDS: Brain ischemia, EPI DWI vs FSE BLADE DWI, MRI at 3 T

Poster 80

Are Superparamagnetic Iron Oxide Nanoparticles Being Used in Renal Failure Patients for Iron Replacement a Future Alternative to MR Imaging Contrast Agent for Patients at Risk for Nephrogenic Systemic Fibrosis?

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Gadolinium (Gd) based MRI contrast agents are used in daily clinical practice and appear safe in most patients; however, nephrogenic systemic fibrosis (NSF) is a recently recognized, severe complication that can affect patients with acute kidney injury or stage 4 or 5 chronic kidney disease (glomerular filtration rate < 30 mL/min/1.73m²) who receive Gd. Contrast-enhanced MRI scans provide additional information and influence patient management; thus, an alternative contrast agent is needed to obtain adequate imaging results but avoid the risk of NSF in this patient group. Ultrasmall superparamagnetic iron oxide nanoparticles (USPIO) are alternative contrast agents, because they short-
en T1 and T2 relaxation times. We review our experience in 150 patients on the potential benefits of USPIOs in central nervous system MR imaging. Safety studies, including USPIO administration (ferumoxytol) as iron supplement therapy in patients on dialysis, indicate that decreased kidney function does not increase toxicity.

**KEY WORDS:** Nanoparticle, MRI, nephrogenic systemic fibrosis

**Poster 81**

**Portable Head CT in a Neurosurgical Intensive Care Unit: Initial Experience**

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**Purpose**

To assess the initial performance of a portable CT scanner in monitoring patients and detecting complications in a neurosurgical intensive care unit.

**Materials & Methods**

A retrospective review of portable CT scans was performed. Patients were scanned in their hospital beds using a customized attachment to connect the bed to the portable CT unit. The following data were obtained: number of portable exams performed, demographic information, admission diagnosis, interval from admission and/or intervention to portable CT scan, findings on portable CT examination, days to follow-up examination, findings on subsequent imaging evaluations. The presence of endotracheal tubes or invasive monitoring devices was noted. Exams and reports were reviewed along with prior imaging studies. Patients were grouped into three categories: those with new findings or significant interval change, those demonstrating expected evolution of existing findings, or exams demonstrating interval stability. Correlation then was performed with conventional CT or MRI scans obtained subsequent to the portable examination.

**Results**

In an initial 6-month period, 38 portable CT scan exams were performed on 24 unique patients. There were 14 male patients (median age 60 years) and 10 female patients (median age 70 years). Seventy-six percent (29/38) of scans were performed postprocedure (median interval 3 days). Short-term follow-up scans were obtained following 31/38 portable examinations (mean follow-up interval 3.65 days). Seventy-one percent (27/38) of exams were performed with at least one invasive monitoring or therapeutic device present. Findings on portable CT were divided into three groups. New findings or significant interval change from the prior exam were present in 32% (12/38) of portable scans. Expected evolution of previous imaging findings was seen in 32% (12/38). Interval stability of findings was demonstrated in 37% (14/38) of exams. Of the 33 portable examinations for which subsequent imaging was available, no new findings were seen on follow-up exams that were not evident on the portable scans. Moreover, no significant findings described on portable CT were absent on subsequent exams.

Among the five patients without additional imaging, four subsequently were discharged; one expired without additional imaging, due to injuries following major trauma.

**Conclusion**

Portable CT offers a reliable means for rapid and safe monitoring of patients in the neurosurgical intensive care setting. It allows for characterization of known imaging findings and accurately portrays the evolving radiologic appearance of intracranial conditions. When used in selected patient groups, portable CT offers the benefits of increased patient safety and departmental workflow without sacrificing clinical performance.

**KEY WORDS:** CT, portable CT, head CT

**Poster 82**

**Long-Term Progressive Encephalomalacia following Traumatic Brain Injury**

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**Purpose**

Stabilization of acute traumatic brain injury generally is thought to occur by 4 months postictus. Although several studies in the literature have suggested that further evolution may occur after this time frame, to our knowledge no prospective human studies have been reported. We elected to investigate this possibility by examining clinically recovered patients up to 2 years posttrauma.

**Materials & Methods**

Patients with traumatic brain injury admitted to the neurorehabilitation program at the Toronto Rehabilitation Institute were recruited prospectively into the study from 2004 until 2007. The primary inclusion criterion was PTA ≥ 1 hour and/or GCS ≤ 12 at Emergency or the scene of accident, and the primary exclusion criterion was known diseases primarily or frequently affecting the central nervous system. Fourteen eligible patients were scanned following initial recovery with baseline MRI at 4-6 months postinjury (mean, 4 months 14 days) and again at 20-35 months (mean, 24 months 23 days). MR imaging was performed on a GE 1.5 T HD system (GE Healthcare, Milwaukee, WI). Sequences included T1 sagittal; GRE, FLAIR, 3D SPGR, and PD/T2 axial; and DTI. Three experienced neuroradiologists reviewed all pairs of imaging studies for each patient, blinded to the temporal sequences of the scans, and all clinical data. Readers were asked to use all available sequences (except DTI) to determine which of the 2 scans had evidence of increased encephalomalacia. If no changes were apparent, they were asked to rate the scans as stable. Subjective evidence of gliosis, hemosiderin deposition, and volume loss were used by the readers to make this assessment.
RESULTS
All three readers were able to correctly identify the early and late scans in eight out of 14 patients based on progression of encephalomalacia. Two of three readers correctly identified progression of encephalomalacia in two of the remaining six encephalomalacia. Two of three readers correctly identified the late scans in eight out of 14 patients based on progression of encephalomalacia. All three readers were able to correctly identify the early and late scans, with potential treatment implications.

CONCLUSION
Longitudinal MRI revealed progressive parenchymal volume loss up to 2 years after the original ictus, indicating that further injury is occurring long after the direct mechanical effects of the traumatic event have resolved. Presumably this is related to prolonged apoptotic and inflammatory cascades, with potential treatment implications.

KEY WORDS: Traumatic brain injury, progressive, encephalomalacia

Poster 83
War-Time Head and Neck Shrapnel Injuries: Value of Multiplanar CT Reformats
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PURPOSE
1. To evaluate ease and reproducibility of multiplanar reformats (MPR) in shrapnel injuries of the head and neck. 2. To determine which type of shrapnel injuries would benefit most from MPRs application. 3. To explore the collateral damage to the vital structures around the injury tract using MPR technique.

MATERIALS & METHODS
Patients with head and neck shrapnel injuries that underwent CT imaging during the second Lebanon war were identified from the hospital trauma data base. Two radiologists retrospectively reviewed head and neck CT and CTA scans and created oblique MPR images along the shrapnel trajectory to depict the full extent of the injury. For each case, comparison was made between the data obtained from the routine axial images, and those obtained by oblique MPR images. Consensus approach was used to decide which set of images provided most information. CT scans were performed on a 16-slice scanner (IDT, Philips Medical Systems). Oblique MPR images were preformed on a Kodak Carestream workstation. The Institutional Ethics Committee approved the study protocol and waived requirement for informed consent.

RESULTS
Twenty-three patients constituted the study group. The patients were divided into following groups: isolated head injuries, facial injuries, neck injuries or a combination of these injuries. Oblique MPR images were found to be most useful in delineating shrapnel trajectory and depicting collateral damage in the following circumstances: 1. Injury to more than one compartment (head, face, neck). 2. Shrapnel trajectory that is not along the axial imaging plane. 3. Injuries involving vascular structures. Oblique MPR images were of limited value when injury trajectory was tangential to the body or along a short distance in the body. The added value of MPR images included: 1. Depicting injury to vascular structures. 2. Depicting bone fractures. 3. Delineating soft tissue injury. We also noted that the technique had short learning time, as performed by the radiology resident, and that it can be used as a fast way to convey information to the treating physician.

CONCLUSION
Obtaining oblique MPR images along shrapnel trajectory is simple and reproducible. Those images are useful for better delineation of shrapnel trajectory and evaluating collateral damage, especially when the shrapnel has a long trajectory within the body that is not along the axial plane and when there is collateral vascular injury. In the scenario of multicausal trauma, those images may be used as a fast way to convey information to the treating physicians.

KEY WORDS: Penetrating trauma, CT

Poster 84
Safety of Unilateral Endovascular Occlusion of the Vertebral Artery
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PURPOSE
Unilateral occlusion of a vertebral artery should be safe as long as the contralateral vertebral artery is patent; segmental vessels as well as the normal confluence of both vertebral arteries provide a rich collateral supply. Antecedent balloon test occlusion is unreliable in demonstrating ischemic deficit, and is not practiced widely. No large series of patients undergoing unilateral endovascular vertebral artery occlusion has been published previously. In one surgical report of 15 patients, the involved vertebral artery was ligated only when larger or equal in diameter to the contralateral vertebral artery. Unilateral vertebral artery ligation did not
result in cerebral or spinal cord ischemia in any of these patients (1). The purpose of this investigation was to determine if unilateral endovascular occlusion of the vertebral artery without prior test occlusion is safe to perform.

**MATERIALS & METHODS**

The records and imaging studies of 65 patients who underwent unilateral endovascular vertebral artery occlusion over a 15-year period were reviewed. Stroke was defined as clinical neurologic deficit consistent with posterior circulation cerebral, cerebellar or spinal cord infarction, or imaging evidence of stroke in the vascular territories supplied by the treated vertebral artery.

**RESULTS**

Fifty-nine patients were treated between 1991 and 2006; 72.9 percent were men and 27.1 percent were women. Mean age was 33.5 years (range 14 to 73). Fifty out of 59 patients were treated to prevent potential embolic complications of traumatic vascular injuries, most often due to deceleration or penetrating trauma. Coils were used to achieve occlusion in 55 patients; balloons, silk suture, or a combination of devices were used in four patients. In three patients, occlusion of a unilateral vertebral artery was performed as part of the treatment plan for a distal aneurysm. In another three cases, unilateral endovascular vertebral artery occlusion was performed prior to surgery for tumor in cervical vertebrae. None of the 59 patients suffered a stroke attributed to intentional vertebral artery occlusion.

**CONCLUSION**

Unilateral endovascular occlusion of a vertebral artery can be performed safely without prior test occlusion, as long as both vertebral arteries are patent and converge at the vertebrobasilar junction. We routinely have performed unilateral vertebral artery occlusion without prior balloon test occlusion in these circumstances regardless of vertebral artery size or dominance. In our series of 59 patients, both dominant and nondominant vertebral arteries were occluded safely. No strokes were attributed to the treatment.

**REFERENCES**


**KEY WORDS:** Endovascular, trauma, stroke

**Poster 85**

Characterization of Cerebral Aneurysm Wall Motion from Dynamic Angiography

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**PURPOSE**

To characterize the motion of cerebral saccular aneurysms and their parent arteries from dynamic angiography images in order to better understand its relationship to the hemodynamics and aneurysm progression and rupture.

**MATERIALS & METHODS**

A total of 21 patients with intracranial aneurysms were included in this study. All patients underwent conventional transfemoral catheterization and cerebral angiography using a Philips Integris Biplane angiography unit. Biplanar dynamic angiograms at 7.5 Hz/2.0 Hz were acquired during a 6-second contrast injection. Cine loops were created making sure that both parent artery and aneurysm are completely filled with contrast in the images included in the series. The motion of the aneurysmal walls and arterial walls were determined by visual inspection of the cine loops. When wall motion was visually observed, the amplitude of the motion was quantified using the following method. All frames were coregistered to the first frame of the sequence using an optical flow algorithm and histogram matching. Then a set of landmark points were selected manually along the aneurysm and artery contours in the first frame and propagated in subsequent frames using the nonrigid deformation field obtained with the optical flow algorithm. The positions of the landmark points then were used to calculate the displacements of the walls.

**RESULTS**

Motion of the aneurysm and/or artery walls were observed visually in 14 of the 21 patients. In seven patients, no motion of either the walls or the aneurysm was observed. Three patients had aneurysms with blebs, and in two of these patients the amplitude of the pulsation of the bleb was twice that of the rest of the sac. In the third patient, no differential motion was observed between the bleb and the rest of the sac. In two patients with basilar tip aneurysms, a small rotation of the aneurysm and a bending motion of the basilar artery in the anterio-posterior direction was observed. In 14 patients the parent vessel showed some pulsation and/or translation and/or bending. Quantification of the wall motion amplitude was not always possible with the current method because of motion artifacts or because the observed movement was small and near the limit of the resolution of the methodology.

**CONCLUSION**

It was possible to observe and in some cases quantify aneurysmal and arterial wall motion using dynamic angiography. The observed wall motion characteristics varied significantly from patient to patient. Nonuniform pulsation of the wall of aneurysms with blebs were observed suggesting that blebs may be manifestation of a focalized wall injury. Further studies are necessary to comprehensively characterize the motion of aneurysms and the connected arteries in order to better understand the interrelationship between wall motion, hemodynamics, wall injury and aneurysm progression and rupture.

**KEY WORDS:** Cerebral aneurysm, wall motion, dynamic angiography


Poster 86

Comparison of CT Angiography, 3D Flat Panel Angiographic CT and 3D Digital Subtraction Angiography in the Evaluation of Simulated Intracranial Aneurysms Treated with Clipping: An In Vitro Study

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PURPOSE
Surgical clip occlusion is one of the primary treatment modalities for intracranial aneurysms. This surgery is technically challenging and visibility of the aneurysm neck often is limited. Small unoccluded portions of the aneurysm may remain at its base. The results of clip occlusion traditionally have been evaluated with digital subtraction angiography (DSA). Advancements in flat panel technology now allow for evaluation with angiographic CT (ACT), which gives planar and 3D images of excellent quality at a lower dose. Parallel advances in CT technology have improved markedly the quality of CT angiography (CTA), and this technology has been proposed as a less invasive method for the evaluation of surgically treated aneurysms. Although the advent of titanium clips has reduced the amount of clip artifact, CT evaluation in the region of the clip is still plagued by beam hardening artifact from the clip. Our aim was to evaluate which modality best demonstrated small neck remnants most reliably.

MATERIALS & METHODS
A phantom was created using a human skull into which a simulated aneurysm was secured in the region of the skull base. Aneurysm occlusion clips were placed across the aneurysm neck. The clip position was varied to obtain varying residual aneurysm sizes. Each residual neck size was evaluated using CTA, ACT, and 3D DSA following contrast administration through the simulated arterial system. MIP and surface reconstructions were reviewed. Clip artifact and the ability to detect the residual neck were evaluated.

RESULTS
Angiographic CT demonstrated the least amount of artifact of the three modalities evaluated. Although all modalities detected most neck remnants, ACT provided the best residual neck depiction.

CONCLUSION
Angiographic CT is superior to both DSA and CT angiography in the evaluation of neck remnants of simulated aneurysms treated by single clip occlusion. However, CTA is able to detect most small neck remnants.

KEY WORDS: Aneurysm, angiography, clip

Poster 87

New Subtraction Technique to Improve the Dynamic Information of Intracranial MR Angiography

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PURPOSE
In this study we investigated a subtraction technique that provides sharper bolus profiles in MR angiography (MRA) resulting in better arterial conspicuity for intracranial arteriovenous malformations (AVMs). There have been many improvements in MRA, but x-ray digital subtraction angiography (DSA) still remains as clinical standard for imaging of neurovascular diseases such as AVMs where arterial phase without any venous contamination is desired. One disadvantage of MRA is that CA is injected intravenously, allowing the bolus to diffuse inside the vascular system, resulting in a broad bolus when the CA reaches the brain. Therefore, the contrast-to-noise between artery and vein decreases. We have studied the front mask subtraction technique that improves the quality of dynamic MRA images.

MATERIALS & METHODS
We applied sliding rear and front masks, where the subtraction mask follows or leads certain number of frames behind the current frame. It has been shown previously that sliding rear mask subtraction provides better artery and vein separation than conventional static masks(1). The subtraction methods were compared in five human volunteers with confirmed AVMs. Patients were imaged on 3.0T Siemens scanner with radial 3D MRA protocol. A multiinjection protocol was used to acquire right lateral, left lateral and coronal scans with stepped contrast dosage, not exceeding 0.3mmol/kg*(body weight). The volunteer images were subtracted in image space using different methods. Contrast-to-noise ratio (CNR) between two ROIs at internal carotid and superior sagittal sinus was measured. Additionally, for AVM patients with large feeding arteries and draining veins ROIs were placed on those vessels. Time-to-peak, the time it takes to reach maximum signal from baseline, also was measured for arterial phases.
RESULTS
The figure shows a comparison of x-ray, rear mask, and front mask subtraction on a volunteer with AVM. Note that with front mask subtraction, the events that are resolved temporally by 6fis x-ray can be seen. By using the front mask, the peak SNR decreased by 26% (±17), but peak CNR increased by 60% (±97), and time to peak decreased by 51% (±10). On the other hand, the corresponding frames with rear mask have lower CNR compared to the front mask subtraction.

CONCLUSION
Although the peak SNR was higher for rear mask, there was significant venous enhancement in the frame with peak SNR. With front mask, sharper bolus profile and better artery-vein separation compensate for decreased SNR and results in higher CNR between artery and vein.

REFERENCES

KEY WORDS: AVM, MRA, angiography

Poster 88
Assessment of Residual Brain Arteriovenous Malformation after Gamma-Knife Radiosurgery: Comparison of 4D MR Angiography with Contrast-Enhanced 3D TOF MR Angiography at 3.0 T

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PURPOSE
Conventional digital subtraction angiography (DSA) is a gold standard imaging study for the follow up of brain arteriovenous malformation (AVM) after gamma-knife radiosurgery (GKRS), but this study is difficult to perform for all patients. Noninvasive MR angiography (MRA) is one of the good options for follow up of treated AVM. In this study, we compared the diagnostic accuracy of 4D MRA and contrast-enhanced 3D TOF MRA for detecting residual AVM in patients treated with GKRS and/or endovascular embolization.

MATERIALS & METHODS
Eighteen patients (13 men and 5 women; mean age, 33 years) were examined by using both 4D MRA and contrast-enhanced 3D TOF MRA at 3 T, during the follow-up periods after GKRS and/or endovascular embolization. The presence or absence of residual AVM on each MRA technique was evaluated by two blind observers on consensus. We calculated the diagnostic accuracy, sensitivity, specificity and interobserver agreement of each modality. The results of DSA were used as a standard of reference.

RESULTS
Nine patients (9/18) were treated with GKRS only, and others (9/18) treated with GKRS and endovascular embolization. The mean duration of follow up after radiosurgery was 38.8 months. Among the 18 AVM, DSA showed 10 complete obliteration of AVM after radiosurgery and/or endovascular treatment. For detecting the presence of residual AVM, the diagnostic sensitivity, specificity, and accuracy of 4D MRA vs 3D TOF MRA were 63% vs 63%, 63% vs 63%, and 90% vs 100% on the basis of consensus reading. Interobserver agreement was good (κ = 0.62) on 4D MRA and excellent (κ = 0.87) on 3D TOF MRA. On review of the 4D MRA and 3D TOF MRA together, the sensitivity, specificity and accuracy of 3T MRA was 75%, 90% and 83%, respectively.

CONCLUSION
In follow up after GKRS of cerebral AVM, combination of 4D MRA and 3D TOF MRA is accurate methods for detecting residual AVM.

KEY WORDS: AVM, MRA, radiosurgery

Poster 89
Familial Cerebral Cavernous Malformations and the Incidence of Concurrent Developmental Venous Anomalies in a Southwest United States Hispanic Population: A Retrospective Study

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PURPOSE
Perform a retrospective review of MRI studies and chart review to determine the incidence of developmental venous anomalies (DVA) in the presence of familial cerebral cavernous malformations (CM). Familial CM have been linked to 3 specific CCM genes, with the KRIT1 Common Hispanic mutation (CCM1) accounting for most cases in the southwest United States. These typically involve: (1) patients of Hispanic origin, (2) multiple CM lesions per patient, and (3) a positive family history. An association exists between DVA and sporadic CM based on MRI studies. In contrast, there appears to be a low association of familial CM with DVA, although no studies have addressed the incidence of DVA in the presence of familial CM in a large cohort, such as the Hispanic southwest population. This patient population of familial cases was compared to sporadic lesions to determine if there were significant differences in the association of DVA with CM.

MATERIALS & METHODS
Patients with familial CM were identified through hospital data bases that record the diagnosis of CM. MR imaging and chart data were reviewed to determine family history and documented genetic mutations. Information was collected on the presence of multiple CM, presence of DVA, positive family history, and Hispanic origin. Incidence of CM and DVA then was analyzed and compared using Fisher’s Exact Test. MR imaging was performed using a 1.5 T system and a few patients with 3.0 T. Cavernous malformations were identified using multiple sequences and measured using T2 and GRE images. The longest dimension was used for calculations. Additionally, signal heterogeneity was determined and noted based on oxidation of hemoglobin products. Gadolinium postcontrast images were analyzed if available to determine lesion enhancement.
RESULTS
There were 46 adult and pediatric scans reviewed: 40 familial CM without DVA, 3 sporadic CM without DVA, 1 familial CM with DVA, and 2 sporadic with DVA. Patients with familial CM had a statistically significant (P < 0.03) low association with DVA when compared with sporadic CM in this population. There were 613 lesions reviewed in the 46 patients: 608 familial CM and 5 sporadic CM. There were 2/5 sporadic CM associated with a DVA and there was 1/608 familial CM associated with a DVA, a significant difference in terms of rate of association in the two populations (P < 1.4X10^-7).

CONCLUSION
From our retrospective review of the southwest Hispanic population we conclude: (1) familial CM are unlikely to be associated with DVA; and (2) more studies are required to further guide the clinical management of familial CM and whether routine gadolinium-enhanced MRI is required in this population. There were 613 lesions reviewed in the 46 patients: 608 familial CM and 5 sporadic CM. There were 613 lesions reviewed in the 46 patients: 608 familial CM and 5 sporadic CM. There were 2/5 sporadic CM associated with a DVA and there was 1/608 familial CM associated with a DVA, a significant difference in terms of rate of association in the two populations (P < 1.4X10^-7).

KEY WORDS: Cerebral cavernous malformation, DVA, familial

Poster 90
Eighty-Three Vertebral Artery Ostium Stenting with Angiographic Follow Up: A Single Center Prospective Series

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PURPOSE
The primary purpose of this study is to evaluate the effectiveness of the vertebral artery ostium stenting. Secondary study goals include: (1) examination of ulcerative plaque prevalence in the vertebral ostium stenosis and (2) assessment of accuracy of noncontrast MR angiography (MRA) in lesions detection.

MATERIALS & METHODS
Seventy-six symptomatic patients underwent attempted primary stenting of vertebral artery ostium. All patients had angiographically proved narrowing of > 50%. If the normal vessel measured ≤ 3.5 mm, a drug-eluted stent (DE) (Taxus, Boston Scientific) was placed. All patients were covered with dual antiplatelet therapy. Technical success was defined as stent placement with < 50% residual stenosis, and no clinical complication. Three and 6 month angiographic follow up was obtained for bare and DE stents, respectively. All patients underwent 12 months poststenting clinical visit. Cerebral angiography was repeated when clinically supported. Data analysis measured plaque ulceration at cerebral angiography prior to intervention, technical success rate, pre/postprocedural stenosis, complication and restenosis rate at angiographic follow up, as well as stroke rate in the vascular territory on clinical follow up. More than 50% narrowing at follow-up angiogram was considered restenosed. Also available MRA prior to intervention were reviewed to assess the accuracy in detection of vertebral ostium lesion.

RESULTS
Seventy-five of 76 patients underwent successful stenting (98.8% success rate); with 83 stents (eight patients had bilateral stents). Mean stenosis rate was reduced from 80% to 10%. Twenty-nine DE stents were placed in 26 patients. Twenty-one patients with 24 stents had follow-up (19 cerebral angiogram, 1 MRA, and 1 ultrasound). Two of 22 stents, 9% needed reangioplasty, one at 28 months poststenting and the second at 9 and 15 months poststenting. No stent occlusion occurred. Fifty-four bare stents were placed in 49 patients. Forty-one patients (with 45 stents), had follow up (42 stents with diagnostic cerebral angiogram, 1 CTA, 1 MRA). Six of 45 stents needed reangioplasty (13.3%). One patient required reangioplasty twice. Two stents were occluded on follow up 2/45 (4.4%). Territorial stroke rate was 0%. Two of 62 patients with clinical follow up had non-territorial strokes (3.2%). Plaque ulceration occurred in 9/76 vessels (11.8%) as seen on presenting angiography. Twenty-one patients with 22 vessels stented had extracranial noncontrast MRA prior to intervention. MR angiography failed to demonstrate the ostial stenosis in 15/22 vessels (68.1%).

CONCLUSION
Stenting of the ostial vertebral artery is safe and effective. Drug-eluting stents have less restenosis rates than bare stents and usually occur later. Plaque ulceration is possible in the ostial vertebral artery and possibly could be the source of embolism. EC MRA without contrast is not useful in evaluation of vertebral ostium stenosis.

KEY WORDS: Vertebral artery, restenosis, stenting

Poster 91
Detection and Characterization of Postsurgical Venous Infarcts and Hemorrhage with Diffusion-Weighted MR Imaging

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PURPOSE
Postsurgical venous infarcts and hemorrhage are clinically relevant, but routine MR imaging (MRI) offers moderate specificity for characterization of these entities on postsurgical imaging. We hypothesized that diffusion-weighted MR imaging (DWI) could improve the detection and characterization of these lesions compared to conventional MR imaging.

MATERIALS & METHODS
Twenty consecutive postsurgical patients with craniotomy and resection for brain tumors (n=20) including glioblastoma (n=7), metastases (n=6), meningioma (n=5) and oligodendroglioma (n=2) were evaluated retrospectively from January 2005 to December 2007. The study was approved by the Institutional Review Board (IRB). MR imaging was performed within 24 hours of surgery and included echo-planar diffusion weighted imaging (DWI) (n=10) (b=1000s/mm2)
and apparent diffusion coefficient (ADC) maps of all patients in addition to other routine MR sequences. Findings on DWI were compared with conventional MRI and the findings were correlated by two readers. All subjects had follow-up MRI after 3 months for comparison and confirmation of initial diagnosis.

RESULTS
A total of 30 lesions were detected either on DWI or other routine MR sequences and were evaluated. These included postsurgical hemorrhage (n=18), venous infarct (n=5), arterial infarct (n=2) and residual tumor (n=5). Venous infarcts were identified as foci of heterogeneous signal due to white matter hemorrhage and vasogenic edema on fluid attenuation inversion recovery (FLAIR) sequence. These showed mixed signal on DWI on initial MRI and resolved on 3-month follow up without evidence of volume loss suggesting venous nature of ischemia. These had heterogeneous foci of increased signal on DWI due to hemorrhagic component within the venous infarction. Large confluent areas of restricted diffusion were observed in 100% (n=18/18) of postsurgical hemorrhages manifested as bright areas on DWI and low signal on ADC maps. These postsurgical hemorrhages were located at the margins of the resection cavity (n=10) or within the operative bed (n=8) whereas venous infarcts were localized in the white matter or gray-white junction. These two entities were differentiated from arterial infarcts (n=2) based on shape and arterial distribution. Hemorrhage was confirmed by evolution to hemosiderin on 3-month follow-up MRI. Five residual tumors [glioblastoma (n=2), meningioma (n=1) and mucinous metastatic lesions (n=2)] had foci of restricted diffusion with enhancement on postcontrast sequence. At least one additional lesion was detected on DWI in six patients compared to conventional MRI and these included hemorrhage (n=4), and arterial infarct (n=2).

CONCLUSION
Diffusion-weighted imaging is a useful sequence in the characterization of postoperative hemorrhage and venous infarction, the former having “homogeneous restricted diffusion” and the latter demonstrating “heterogeneous pattern”. This sequence also is helpful in detecting additional lesions on immediate postsurgical brain imaging compared to conventional MR imaging. During the initial presentation, hemorrhage will consistently show high signal on DWI. This can be attributed to intracellular nature and high viscosity in early hemorrhage, which is different from venous infarction which has vasogenic edema and white matter hemorrhage that can give rise to variable imaging appearances on DWI.

KEY WORDS: Diffusion-weighted imaging, venous infarct, hemorrhage

Poster 92
Rapid Estimation of Intraventricular Hemorrhage Volume

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PURPOSE
Intraventricular extension of intracerebral hemorrhage (IVH) is a morbid condition and an independent predictor of poor outcome. IVH volume may be important in outcome prediction and management; however, it is difficult for radiologists to measure routinely. We propose a formula for estimating IVH volume based on a simple classification system termed IVH score (IVHS).

MATERIALS & METHODS
We reviewed the charts and CTs of a cohort of consecutive patients with IVH. The cohort was divided into two groups: index and validation by random sampling. One hundred seventy-five patients were analyzed, 92 in the index group and 83 in the validation group. IVH and intracerebral hematoma (ICH) volume were measured manually by drawing regions of interest. IVHS was determined in each patient. Each lateral ventricle received a score of 0 (no blood), 1 (up to one-third filled with blood), 2 (one to two-thirds filled with blood) or 3 (more than two-thirds or completely filled with blood). The third and fourth ventricles received a score of 0 for no blood or 1 if they were partially or completely filled with blood. To account for the presence of hydrocephalus we weighted the total score by a factor of two when hydrocephalus was present. Since the lateral ventricles contribute more to ventricular volume (9:10:1) compared to the third and fourth ventricles we weighted the lateral ventricles by a factor of three.

RESULTS
The final formula for calculating the IVHS was [3x(RV+LV)+III+IV]xH where H represents the presence of hydrocephalus (1 for no hydrocephalus, 2 for hydrocephalus present). In the index group, IVHS correlated highly with IVH volume (R²=0.8, p<0.001). Linear regression yielded the following formula for estimating IVH volume (in cc): 1.3 x IVHS. This formula then was validated in the validation group. Clinical outcome was defined by modified Rankin Scale (mRS) at discharge, and in-hospital death. mRS > 3 was considered poor outcome. IVH volume showed a moderate correlation with mRS (r=0.3, p<0.001). The sum of IVH volume and ICH volume (TV) showed much higher correlation (r = 0.54, p < 0.001). A cutoff of 50 cc TV was identified beyond which 95.8% of patients had a poor outcome.
Conclusion
We provide a novel method for rapidly estimating IVH volume based on a simple grading system, IVH score, which will allow radiologists to provide clinicians with a useful quantitative measure of hemorrhage burden, especially when measured in conjunction with ICH volume.

Key Words: Intracranial hemorrhage, intraventricular hemorrhage, intraventricular volume hemorrhage

Poster 93
Perfusion CT Provides Evidence against a Perihemorrhagic Penumbra

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Purpose
Several recent studies analyzing perfusion changes in acute intracerebral hemorrhage fed the debate whether there is secondary ischemic tissue damage in the vicinity of intracerebral hemorrhage. We used perfusion CT to address this question.

Materials & Methods
We examined 36 patients between 2001 and 2002 with acute intracerebral hemorrhage (within 24 hours after symptom onset). A subgroup of eight patients was examined serially on day 1, between days 2 and 4, and after day 5. Nonenhanced CT images and maps of cerebral blood flow, cerebral blood volume, and time to peak were evaluated by region of interest analysis.

Results
In comparison to the contralateral hemisphere, perfusion values were clearly reduced around the hematoma (relative values: cerebral blood flow 0.51, cerebral blood volume 0.62, time to peak 1.7 seconds). There was no difference in size between the area of reduced perfusion and the area of edema (5.17 versus 5.75 cm2, respectively) surrounding the hematoma. At time point 2, the edema grew significantly.

Conclusion
In accordance with previous studies, we found reduced perfusion as well as edema surrounding acute intracerebral hemorrhage. Regarding ischemic tissue damage, we did not detect an initial mismatch between the perfusion deficit and the edema and therefore could not identify any tissue at risk of ischemia. We therefore interpret the reduced perfusion as a secondary phenomenon (i.e., reduced oxygen demand of tissue damaged by pressure and clot components) not as the cause of any tissue damage associated with acute intracerebral hemorrhage.

Key Words: Perfusion CT, perihemorrhagic penumbra
Poster 94

A Novel Technique of Cranial MR Angiography: Hybrid MR Angiography

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PURPOSE

Three-dimensional time-of-flight (TOF) MR angiography (MRA) have some limitations such as signal decline of peripheral and slowly-flowing vessels due to saturation effect. In contrast, we showed that black blood imaging using a 3D gradient-echo sequence and dephasing gradients (flow-sensitive black blood: FSBB) was a feasible technique for visualizing small and slowly flowing vessels. We developed a new MRA sequence, hybrid MRA (HMRA), combining the contrast of TOF and FSBB by using the dual-echo data acquisition. The purpose of this study was to evaluate the utility of this technique from the initial clinical experiences.

MATERIALS & METHODS

Nineteen patients with steno-occlusive cerebral vascular diseases underwent MR examination including a 3D TOF MRA and HRMA. Eleven patients had a history of extracranial (EC)-intracranial (IC) bypass operation. All examinations were performed on a clinical 1.5 T scanner (EXCELART Vantage ZGV, Toshiba). Pulse sequence of the HMRA was designed with a 3D dual-echo gradient-echo sequence. In this study, TR of 31.2 ms and TE of 6.4/23.8 ms were selected. The gradient moment nulling (GMN) and dephasing gradient was applied to obtain the first and second echo, respectively. Original images of the HMRA were made by subtracting the second-echo images from the first-echo images with a variable weighting coefficient. Maximum intensity projection (MIP) was performed in the same way as the TOF MRA.

RESULTS

In 8 patients with steno-occlusive vascular disease including moyamoya disease, visualization of the peripheral arteries was improved on HMRA compared with 3D TOF MRA using a MTC pulse. In three patients with moyamoya disease and a patient with occlusion of the middle cerebral artery (MCA), some distal branches not visualized on TOF MRA were visualized on the HMRA. In the patient with MCA occlusion, retrograde filling of the distal branches of the MCA via the leptomeningeal anastomoses was revealed on the DSA. In 11 patients who had undergone EC-IC bypass operation, HMRA seemed to be of equal value with 2 slab TOF MRA using fat saturation and MTC pulses in spite of its shorter acquisition time. One of the problems with this technique was the susceptibility artifacts especially in the skull base. Because this technique was based on the subtraction between images with a different TE, the intensity of fatty tissue could not be totally subtracted in some instances.

CONCLUSION

HMRA can be a feasible tool for evaluating intracranial arteries, especially in patients with steno-occlusive vascular diseases.

KEY WORDS: MR angiography, dual echo

Poster 95

Enhancement Patterns of the Cavernous Sinus on Computed Tomographic Angiography

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PURPOSE

Irregular contrast enhancement of the cavernous sinus on computed tomography (CT) may be used as an imaging criterion to indicate pathology within the cavernous sinus such as thrombus, fistula or tumor. We aimed to demonstrate the expected patterns of cavernous sinus opacification on intracranial CT angiography in subjects without cavernous sinus pathology.

MATERIALS & METHODS

We reviewed 314 consecutive clinical intracranial CT angiographic studies (M:F=134:180, mean/median age: 50.56/51 years). Performed at a tertiary neurosciences center with a standardized technique. The cavernous sinus contrast opacification was scored according to its anteroposterior extent and laterality. Anteroposterior extent was defined as anterior/mid/posterior segments according to its relationship with the internal carotid artery (ICA). The degree of contrast opacification also was assigned a score from 0 to 2 (0 - no contrast; 1 - contrast enhancement density less than that of the adjacent ICA; 2 - contrast enhancement density comparable to that of the adjacent ICA). Results were subdivided by complete, incomplete or absent cavernous sinus opacification. Cavernous sinus direction of fill (DOF) was analyzed in patients with bilateral incomplete or inhomogenous opacification. Magnitude of sinus enhancement (MOE) was calculated as a sum of the contrast enhancement scores for an individual sinus for all patients (range 0 to 6). Statistical analysis was performed using a two-tailed unpaired Student’s t-test.
RESULTS
Complete homogenous contrast enhancement of a cavernous sinus was present in 55% of patients, whilst bilateral incomplete or inhomogeneous enhancement occurred in 35%. Absence of contrast enhancement of a cavernous sinus was present in 10% of patients. Direction of fill was anterior only, posterior only, mixed or central in 3.0%, 79.1%, 17.2% and 0.75% of sinuses respectively. Direction of fill was symmetrical in 80.5% of sinuses in patients less than 50 years of age. For patients above 50, DOF was anterior only, posterior only, mixed or central in 3.0%, 79.1%, 17.2% and 0.75% of sinuses respectively. Direction of fill was symmetrical in 80.5% of patients. A small but significant (p = 0.02) difference between mean MOE between patients less than 50 (4.1) and at/above 50 (3.7) years of age was observed.

CONCLUSION
There is considerable variation in the pattern of cavernous sinus filling observed on CT angiography. There is an observed pattern of predominantly posterior filling of the cavernous sinus which would appear contradictory to the accepted pattern of drainage into the cavernous sinus from the deep draining minor sinuses and veins; this, however, may be consistent with early DSA and dynamic contrast CT studies of the cavernous sinus. The variation as demonstrated suggests a complex filling pattern of the cavernous sinus that may erroneously simulate pathology within the cavernous sinus. Our data are suggestive of a small significant difference in magnitude of enhancement of the cavernous sinus between patients < 50 and > 50 years of age.

KEY WORDS: Cavernous sinus

Poster 96

Evaluation of Subjects with Subarachnoid Bleeding for Perfusion Deficit and Vasospasm: Relation of Perfusion Deficit to the Degree of Vasospasm

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PURPOSE
In this study, CT angiography (CTA) and CT perfusion (PCT) findings of subjects with aneurysmal subarachnoid bleeding were evaluated in terms of vasospasm, perfusion deficit and the relation of perfusion deficit to the degree of vasospasm.

MATERIALS & METHODS
Thirty-five subjects with subarachnoid bleeding were enrolled. Sixty-four channels MDCT were used. First, PCT was performed (5 ml/sn with total 50 ml iodinated contrast agent, 4 slices with a thickness of 8 mm starting from the level of basal ganglia toward inferior). Fifteen minutes later, CTA was performed starting from the 1 cm inferior to the foramen magnum to the vertex (5 ml/sn with total 50 ml iodinated contrast agent). Perfusion deficit was noted as reversible with spared rCBV, decreased rCBF and prolonged MTT and irreversible with decreased rCBV, rCBF, and prolonged MTT. Vasospasm was graded as mild or moderate or severe based on narrowing of the vessel lumen less than 25% or between 25-50%, or above 50%, respectively.

RESULTS
Vasospasm was noted in 54% of all subjects, of all, 40% were minimal and/or moderate; 14% were severe in degree. Perfusion deficit was noted in 29% of all subjects. We grouped the subjects with vasospasm into one with mild and/or moderate vasospasm and other with severe vasospasm. The frequency of perfusion deficit was found to be 21% in subjects with mild and/or moderate vasospasm and 80% in subjects with severe vasospasm.

CONCLUSION
In recent years, CTA has largely replaced the conventional angiography in evaluation of patients with subarachnoid bleeding. Physiologic imaging via PCT is another advantage to conventional angiography. We found the frequency of perfusion deficit to be 21% among the patients with minimal and/or moderate vasospasm and 80% among the patients with severe vasospasm. The noticeable difference between two groups show us the importance of perfusion imaging among the subjects with subarachnoid bleeding in which severe vasospasm is detected.

KEY WORDS: Vasospasm, perfusion defect, subarachnoid bleeding

Poster 97

Sellar Lesions in Systemic Diseases: MR Imaging

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PURPOSE
To study the frequency and the MR imaging patterns of lesions located in the sellar region in case of systemic diseases.

MATERIALS & METHODS
Study of 181 consecutive patients presenting with systemic disease and pathologic cerebral MRI. There were 30 patients with proved sarcoidosis, 44 with Behçet disease, 10 with Wegener disease, 9 with Gougerot-Sjögren disease, 8 with Langerhans histiocytosis, 27 with Erdheim-Chester disease, 28 with systemic lupus erythematosus and 25 with anti-phospholipids syndrome. Frequency, accurate location (hypothalamus, stalk, pituitary gland, cavernous sinus), size and enhancement patterns of sellar lesions were analyzed retrospectively.

RESULTS
In our series, sellar lesions were observed in 10/30 sarcoidosis (33%), 6/27 Erdheim-Chester disease (22%), 2/8 Langerhans histiocytosis (25%) and 2/10 Wegener disease patients (20%). No lesion was observed in the sellar region in case of Behçet disease, Gougerot-Sjögren disease, systemic lupus erythematosus or anti-phospholipids syndrome. MR imaging mostly demonstrated multiple hypothalamic small or confluent nodules in sarcoidosis, single nodule of the hypothalamus or stalk, associated with other facial, orbital or meningeal lesions in histiocytoses, cavernous sinus involvement from contiguous extension of a skull base lesion in Wegener disease.
CONCLUSION
This study confirms the relative high frequency of sellar lesions in case of systemic diseases and offers more details on their MR patterns.

KEY WORDS: Systemic disease, sellar area, MRI

Poster 98
Brain Diffusivity in Patients with Systemic Lupus Erythematosus

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PURPOSE
To investigate whether diffusion-weighted imaging (DWI) can depict cerebral abnormalities in patients with systemic lupus erythematosus (SLE) and if significant differences in measured ADC histograms between these patients and normal controls exist. This study is an important adjunct to a prior study comparing brain diffusivity in patients with acute neuropsychiatric systemic lupus erythematosus (NPSLE) and healthy controls.

MATERIALS & METHODS
Conventional MRI of the brain and diffusion-weighted echoplanar imaging (DWI) were performed on 3T scanner (Archiva, Philips, Netherlands) in 10 female SLE patients, aged 35-59 years, mean age 44.4 years, and in 11 age-matched healthy controls (HC). Whole brain apparent diffusion coefficient (ADC) histograms were constructed in all patients. To remove noise and CSF contributions, explicit cuts were done at 100x10^4 mm^2/sec and 2000x10^4 mm^2/sec in the ADC values and each subject’s histogram was normalized to have the sum of 1. The mean ADC, the width of the ADC distribution, the left to right distribution (skewness) and how the histogram extended (kurtosis) was evaluated in each subject. Average values and SD were calculated. P-value <0.05 was set for statistical significance using Students’ t-test.

RESULTS
Fourteen patients (67%) had abnormal findings on MR imaging. The most common findings were scattered single or multifocal foci or patchy areas of increased signal on T2-weighted and FLAIR images in the deep and in the periventricular white matter without any pathologic contrast enhancement. Other abnormal findings included acute and old infarcts, volume loss or brain atrophy and pathologic meningeal contrast enhancement. No significant abnormalities were seen in the HC except for incidental findings of a few foci of increased signal on T1WI and FLAIR along with a right internal carotid aneurysm in one subject. The SLE patients had a mean normalized ADC value of 0.907 and the control had a mean normalized ADC value of 0.904. Our initial analysis shows no significant difference in ADC values in the SLE patients compared to the controls. This is an unexpected result given the prior report indicating significant increased diffusivity of neuropsychiatric SLE patient. Over the next few months, this analysis will be expanded to include more SLE patients and controls along with comparison to the NPSLE patients group in the prior study.

CONCLUSION
Early results from investigating normalized total brain diffusivity show no significant difference between the brains in SLE patients as compared with healthy normal controls. Yet prior analysis showed significant increased diffusivity in patients with neuropsychiatric SLE. This finding suggests that the brain parenchyma of SLE patients and neuropsychiatric SLE patients are markedly different. However, the power of this initial investigation is inadequate. Additional patients with SLE and control patients will be added to this study to provide more conclusive results. Diffusivity may yet prove to be a marker of disease progression and used in assessing treatment response.

KEY WORDS: Diffusivity, SLE

Poster 99
Is Bone Enhancement a Helpful Finding in the Diagnosis of Convexity Meningiomas?

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PURPOSE
The differential diagnosis between peripheral intraaxial lesions with secondary dural infiltration versus extraxial mass lesions is paramount prior to surgery. This is essential in planning the surgical approach, informing the patient of the procedure, its risk and disease prognosis. Occasionally the diagnosis of superficially located lesions on MRI can be controversial due to the overlapping of imaging findings. The aim of the study is two fold. First, the authors wanted to validate retrospectively the hypothesis of “Enhancement of the overlying bone” on postgadolinium-enhanced MRI in
patients with convexity meningiomas. Second, to validate this finding in case of extraaxial and peripherally located intraaxial lesions with dural enhancement.

**MATERIALS & METHODS**

First, 51 continuous patients harboring a convexity meningioma were selected by the primary investigator from the institutional imaging data base. These patients were assessed blindly by two senior neuroradiologists for the overlying bony enhancement adjacent to the meningioma. For this purpose the bone overlying the contralateral cerebral hemisphere was used as the reference. Second, 81 patients with either an extraaxial or an intraaxial lesion with overlying dural enhancement were selected by the primary investigator. These patients were assessed blindly by two senior neuroradiologists to evaluate the overlying bone enhancement. Then the final diagnosis based on the overall appearance of the lesion was done and verified with the histopathologic findings.

**RESULTS**

In the first group, unilateral and asymmetric enhancement in the overlying bone was seen in 40/51 (78.5 %) of the patients. Patients with absent enhancement in the bone were harboring lesions ranging in size from 1.3 to 3.6 cm and there was no diagnostic dilemma in their diagnosis from their imaging findings. Focal asymmetric enhancing foci in the overlying bone were noted in 9/30(30%) of intraaxial lesions with secondary dural enhancement. Inspite of the overlying bony enhancement, these intraaxial lesions did not pose a dilemma in their imaging diagnosis due to classical features of an intraaxial lesion. In three patients with diagnostic dilemma of an extraaxial versus intraaxial lesion, the presence or absence of overlying bone enhancement helped in making the correct distinction.

**CONCLUSION**

Focal enhancement in the overlying bone in convexity meningiomas is an MRI finding which has not been described yet in the literature. This finding may be useful and it can be applied in differentiating an extraaxial lesion from a peripheral intraaxial lesion when the imaging is controversial.

**KEY WORDS:** Bone enhancement

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**Poster 100**

**Minimum Apparent Diffusion Coefficient within Contrast-Enhancing Region Is Predictive of Clinical Outcome in Primary Central Nervous System Lymphoma**

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**PURPOSE**

The incidence of primary central nervous system lymphoma (PCNSL) has increased gradually, now representing up to 3% of all primary brain tumors. Survival has improved markedly since the use of Methotrexate-based chemotherapy; however, a significant cohort exhibit refractory disease.

It has been reported that PCNSL apparent diffusion coefficient (ADC) values inversely correlate with histopathologic assessment of tumor cellularity. Furthermore, increased tumor cellularity with an active STAT6 pathway is associated with refractory disease, early progression, and poor survival. The purpose of our study was to determine whether minimum ADC (ADCmin) values obtained within contrast-enhancing regions of PCNSL patients prior to initiation of treatment correlates to time-to-disease progression and overall survival.

**MATERIALS & METHODS**

Diffusion-weighted imaging (DWI) was used retrospectively to study contrast-enhancing lesions in 18 patients with PCNSL (10 men, 8 women, mean age 57±15 years; all immunocompetent except one). All patients were treated identically with high-dose Methotrexate-based chemotherapy (3-8 g/m²). All patients underwent DWI prior to treatment using a 1.5 T MR scanner. DWI processing using nonproprietary software produced ADC maps. ADCmin values within a region of interest, defined by the extent of contrast enhancement, was obtained. High (N=9) and low (N=9) ADCmin groups were stratified based on the cohort’s mean ADCmin value of 377(µm²/sec). Following initial treatment, disease progression was defined radiologically as greater than 25% increase in contrast enhancement of primary lesion or development of new enhancing areas on follow-up imaging. Survival analysis was performed using a log-rank test. A P-value of less than 0.05 was considered statistically significant.

**RESULTS**

Time from clinicoradiologic diagnosis to initial treatment and total volume of enhancement were found not to be statistically significant (Table). Mean ADCmin values were significantly lower within the low ADCmin group compared to the high ADCmin group (Table). Patients with enhancing PCNSL lesions which contained ADCmin values of less than 377µm²/sec experienced early disease progression and shorter overall survival despite receiving identical treatment as the high ADCmin group. Time to disease progression was significantly shorter within the low ADCmin group (P < 0.01). Overall survival in the low ADCmin group was markedly shorter than patients in the high ADCmin group (P < 0.01). Mean survival time was significantly shorter within the low ADCmin group (P=0.03).

**CONCLUSION**

Currently there are no established imaging markers which stratify clinical outcome in PCNSL patients. Although the relatively small sample size of this retrospective study cautious against over interpretation, our preliminary data suggests minimum ADC values obtained within the enhancing region of PCNSL lesions may be a predictive imaging marker of clinical outcome. Further prospective research with larger sample size and longer follow-up is being conducted to further evaluate minimum ADC as a predictor of clinical outcome and usefulness in clinical decision-making.

**KEY WORDS:** Brain, lymphoma, ADC
Conventional MR Imaging Characteristics of Human Astrocytomas: Correlation with TP53 Molecular Mutation

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PURPOSE
Genetic analysis of surgical specimens allows for molecular subtyping of brain tumors. TP53 gene makes p53 protein, which acts in the cell cycle to conserve the integrity of DNA. Cellular stress causes p53 to halt the cell cycle or force apoptosis, preventing the replication of damaged DNA (and tumorigenesis). TP53 mutations are early and frequent genetic alterations in the pathway leading to secondary glioblastoma multiforme (GBM) and are found in 59% of low grade astrocytomas, 53% of anaplastic, and 65% of secondary GBMs, while only present in 28% of primary GBMs. A radiographic noninvasive predictor of TP53 mutation in astrocytoma subtypes would be of value in assessment of biology, prognosis, and therapy, and also could be used to predict possible malignant transformation of low-grade glioma into GBM. The purpose of this study is to determine if there are magnetic resonance imaging (MRI) findings which correlate with TP53 mutation in astrocytomas.

MATERIALS & METHODS
We reviewed 32 patients with astrocytoma who underwent surgical resection, classified using the WHO criteria, and had molecular examination for TP53 mutation. The altered protein product of the mutant gene has an extended half-life and can be detected with immunohistochemical techniques. Detectable nuclear immunohistochemical staining was recorded as positive. Patients underwent conventional MRI with T1-weighted pre and postcontrast, T2-weighted imaging, fluid attenuated inversion recovery (FLAIR), and T2-gradient echo imaging (GRE). MR imaging scans were reviewed for the following: (a) location of lesion; (b) mass effect; (c) T2 signal intensity; (d) presence of enhancement; (e) lesion size; (f) T2 border sharpness; (g) necrosis; (h) presence and degree of edema; (i) presence of blood products.

RESULTS
There were 6/32 (19%) grade II, 8/32 (25%) grade III, and 18/32 (56%) grade IV. Of all astrocytomas, TP53 mutation was positive (+) in 18/32 (56%) patients and negative (-) in 14/32 (44%). TP53 was positive in 1/6 (16%) of grade II, 6/8 (75%) of grade III and 11/18 (61%) of grade IV. The presence of TP53 mutation (+) correlated with the finding of blood products/hemorrhage, necrosis, mass effect and degree of edema with correlation coefficients of 0.91, -0.58, 0.41 and 0.84 respectively (P < 0.05). There was no correlation with the other MRI findings described above. Contrast enhancement was demonstrated in 17/18 (94%) patients with TP53+ whereas was only in 9/14 (64%) with TP53-. Edema was present in 15/18 (83%) of TP53+ and 8/14 (57%) of TP53- patients. However, importantly when we review the 18 GBMs, there was more edema in TP53- GBMs (likely primary GBMs) 4/7 (57%), than in TP53+ GBMs (likely secondary GBMs) 4/11 (36%). This indicates that lesions with TP53- are more likely primary GBMs with more edema.

CONCLUSION
Finding blood products/hemorrhage, necrosis, mass effect and degree of edema may be positive indicators for TP53 molecular mutation on MRI. Finding less edema in TP53+ GBMs could be explained by their origin as grade II astrocytomas, possibly with less aggressive biological behavior as these are secondary GBMs.

KEY WORDS: Astrocytoma, MRI, genetic analysis TP53
RESULTS
A tumor might contain one or two types of PSA. Reversible PSA were found in eight patients (3 meningiomas, 2 AA, and 3 GBM) and irreversible in 13 patients (3 meningiomas, 3 AA, and 6 GBM). Mean FA ratios for reversible PSA and irreversible PSA were 0.511±0.089 and 0.306±0.056, respectively with statistically significant differences (p<0.0001). For intragroup comparison of reversible PSA, the mean FA ratios of meningiomas (n=3) and gliomas (n=5) were 0.479±0.073 versus 0.530±0.101, respectively, and were 0.292±0.061 (4 meningiomas) versus 0.321±0.057 (9 gliomas), respectively, for irreversible PSA. They both showed no significant differences (p=0.393 and 0.604).

CONCLUSION
The reversibility of PSA is predictable by FA ratios derived from DTI. It is irrelevant to tumor types. The findings support our hypothesis that DTI is able to differentiate peritumoral tissue contents. The new model for peritumoral tissue characterization may assist to refine the delineation of therapeutic targets. It may not predict only postsurgical outcome but also serve as a biomarker for target delineation in radiation therapy (as primary or adjuvant treatment) and therefore improve therapeutic effects.

KEY WORDS: DTI, brain tumors, tissue characterization

Poster 103
Withdrawn

Poster 104
Comparison of Normalized Cho (Cho/n/Cho,0) to Cho/n/NAA,0 and Cho/n/Cr,0 in the Characterization of Glioma Grade in a Multicenter Study
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PURPOSE
The purpose of this study is to compare traditional unilateral intratumoral ratios of choline/N-acetylaspartate (Cho/n/Naa,0) and choline/creatine (Cho/n/Cr,0) with a new ratio between ipsilateral tumoral Cho,0 and the normal Cho,0 within the contralateral normal-appearing brain (Cho,0 / Cho,0) for glioma grading.

MATERIALS & METHODS
Fifty patients with gliomas and 10 controls were studied prospectively with multivoxel MR spectroscopy (TR = 1,500/TE=35ms). All patients had histopathologic confirmation (WHO Classification and were divided into Low Grade II versus High Grade III-IV). The volume of interest included the tumor and normal contralateral brain. The highest tumoral Cho,0/Cr,0, Cho,0/Naa,0 and Cho,0/Cho,0 ratios were calculated.

RESULTS
For Cho/n/NAA,0 and Cho/n/Cr,0 ratios, significant differences (p<0.001) were found between the glioma groups compared to normal tissue. Cho/n/NAA,0 ratio were 0.57 ± 0.21 in the control group, 2.21 ± 0.85 Grade II and 1.47 ± 0.80 Grades III-IV. Cho/n/Cr,0 ratios were 1.16 ± 0.26 control group, 2.90 ± 1.32 Grade II, and 2.83 ± 1.67 Grades III-IV. Normalized Cho (Cho/n/Cho,0) were 1.47 ± 0.63 Grade II, 2.00 ± 2.33 Grades III-IV. The normalized Cho/n/Cho,0 is the only ratio that tend to increase in higher glioma grade with significant difference (p<0.05) between High Grade and controls.

CONCLUSION
Cho/n/NAA,0 and Cho/n/Cr,0 ratios appear to be better in differentiating between neoplastic and normal tissue. These ratios are lower in Grade III-IV due to necrosis. Cho/n/Cho,0 shows tendency to increase with grade, possibly overcoming the effect of necrosis and tumor heterogeneity. Survival data will determine if Cho/n/Cho,0 is superior in the determination of glioma biology.

KEY WORDS: Short TE multivoxel spectroscopy, astrocytomas, tumor grade

Poster 105
Cisternal Angle: A Critical Radiographic Measure to Assess Prior to Embolization of Intracranial Tumors
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PURPOSE
Embolization of intracranial tumors can be a useful peroperative adjunct. Sometimes such embolization results in acute neurologic deterioration. The purpose of this study is to outline radiographic features including a new measure termed the cisternal angle that portend risk factors for preoperative embolization.

MATERIALS & METHODS
A retrospective review of 12 patients with large intracranial tumors who underwent embolization was conducted. Preoperative MRI was analyzed for location and size of the tumor, evidence of herniation, and midbrain compression. All 12 patients underwent catheter angiogram and particle/coil embolization. The degree of tumor blush reduction and any change in the neurologic status was recorded. To quantify degree of midbrain compression, we introduce a new measure termed the cisternal angle. The cisternal angle is measured on an axial T2WI in the Talairach plane, at the level of the midbrain where the red nucleus is seen. It is the angle formed at the intersection of a line drawn along the midsagittal plane and a line drawn along the anterior aspect of the cerebral peduncle. This cisternal angle was measured in all patients and in an age-matched control population (n = 100). Statistical analysis was performed using Wilcoxon-Signed Rank test to compare the right and the left sides in each individual patient. In the control group, the paired-t test was used to compare the cisternal angle between the right and left side.


RESULTS

**Cisternal Angle. Control Population.** The mean cisternal angle measured 42.8 ± 3.7° and 43.5 ± 3.7° on the right and left sides respectively with no statistically significant difference between the two sides (p = 0.20). Patient Population. Of the 12 patients, nine experienced no change in neurologic exam after embolization. The mean cisternal angle measured 41.7 ± 4.4° and 46.2 ± 4.0° ipsilateral and contralateral to the tumor respectively with no statistically significant difference between the two sides (p = 0.13). In contrast, in the three patients that deteriorated after embolization, the mean cisternal angle measured 21.5 ± 4.1° and 50.7 ± 7.3° ipsilateral and contralateral to the tumor and a statistically significant difference was noted (p < 0.05). These measurements were greater than five standard deviations from the mean. Based on the statistical analysis, a difference of 5-10° in the cisternal angle between the side ipsilateral and contralateral to the tumor was considered as mild, 10-20° moderate, and greater than 20° as severe midbrain compression. Only patients who demonstrated severe midbrain compression deteriorated postembolization. **Vascular Supply and Embolization.** All three patients who clinically deteriorated showed a strong tumor blush with significant tumor blush reduction postembolization. All these three patients also demonstrated severe midbrain compression. In contrast, of the nine stable patients, six demonstrated mild to moderate tumor blush reduction, while three patients demonstrated significant tumor blush reduction. None of these nine patients demonstrated severe midbrain compression.

**Conclusion**

The cisternal angle is an objective measure of midbrain compression. The presence of a significantly acute cisternal angle and associated significant reduction in the tumor blush are high risk factors for clinical deterioration postembolization.

**Keywords:** Embolization, tumor, cisternal angle

Poster 106

**Role of PROPELLER Diffusion-Weighted Imaging and Apparent Diffusion Coefficient in the Diagnosis of Sellar and Parasellar Lesions**

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**Purpose**

The aim of this study is to evaluate the role of apparent diffusion coefficient (ADC) using periodically rotated overlapping parallel lines with enhanced reconstruction (PROPELLER) diffusion-weighted imaging (DWI) in the differentiation between various sellar and parasellar lesions.

**Materials & Methods**

We retrospectively studied the sellar and parasellar lesions that were newly diagnosed and operated between October 2006 and November 2007 in Hiroshima University Hospital. This study population consists of 54 patients: 38 pituitary adenomas (24 nonhemorrhagic and 14 hemorrhagic), 7 Rathke’s cleft cysts, 5 meningiomas and 4 craniopharyngiomas. A 3.0 T superconducting magnetic resonance (MR) imaging system was used to obtain conventional MR images and PROPELLER DWI. The b values were set at 1,000 sec/mm², and the ADC maps were obtained by calculating the signal intensity of the DWI at 2 different b values (0, 1,000) on a pixel-by-pixel basis. The ADC was measured by manually placing regions of interest (ROI) on lesions.

**Results**

The mean ADC value of hemorrhagic pituitary adenomas was 0.712 ± 0.121 (range 0.419 - 0.977) x 10⁻³ mm²/sec which was lower than the mean ADC value of nonhemorrhagic pituitary adenomas [1.07 ± 0.233 (range 0.634 - 1.59) x 10⁻³ mm²/sec] (P < 0.01) and that of Rathke’s cleft cysts [2.10 ± 0.60 (range 1.11-2.91) x 10⁻³ mm²/sec] (P < 0.01). The mean ADC value of meningioma was 0.858 ± 0.101 (range 0.752 - 0.973) x 10⁻³ mm²/sec which was lower than the mean ADC value of nonhemorrhagic pituitary adenomas (P < 0.05). There was no statistical difference between the ADC values of Rathke’s cleft cysts, cystic pituitary adenomas and craniopharyngiomas.

**Conclusion**

PROPELLER DWI is less subjected to susceptibility artifacts than single-shot echo-planar DWI so it is more useful in the examination of sellar and parasellar lesions. Apparent diffusion coefficient is helpful in differentiation between various sellar and parasellar lesions, especially pituitary adenoma versus meningioma, hemorrhagic versus nonhemorrhagic pituitary adenoma, and Rathke’s cleft cyst versus hemorrhagic pituitary adenoma.

**Keywords:** Adult brain

Poster 107

**Intracranial Calcifying Pseudoneoplasms: CT and MR Imaging Characteristics**

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**Purpose**

Fibro-osseous masses within the central nervous system (CNS) also known as “calcifying pseudoneoplasms of the neural axis” are extremely rare and occur as intra or extraxial space-occupying lesions. Since their first initial description in 1978, less than 30 such lesions have been reported in the medical literature. We present four intracranial fibro-osseous lesions and describe their pathologic as well as CT and MRI appearances, and discuss pertinent features that may distinguish them from other neoplasms and nonneoplastic lesions.

**Materials & Methods**

The Department of Pathology Archives at our institution were reviewed to identify all fibro-osseous lesions that could be classified as calcifying pseudoneoplasms. Four such cases were identified over a period of 10 years. After review of pathologic features in these four patients, the clinical and imaging characteristics were analyzed. MRI scans were
reviewed for all four patients. CT scans were available for three patients with diagnostic angiography in the fourth patient.

RESULTS
All patients underwent complete resection (primary resection in three cases and secondary resection in one case) of the calcified mass with histopathologic diagnosis of “fibro-osseous lesion.” The patients ranged in age from 16 to 59 years with three males and one female patient. Three adult patients presented with a history of long-standing seizures and one lesion was found incidentally in the youngest patient who had a head CT for trauma. The three patients with a history of seizures had intraaxial brain masses, ranging in size from 1cm to 1.8cm, located in the right parietal lobe near the postcentral gyrus, in the left hippocampus, and in the right temporal lobe, respectively. The fourth case, an incidentally found lesion, was a 3.2 cm extraaxial intraventricular mass. In all four cases, the MRI scans demonstrated markedly hypointense signal on both T1- and T2-weighted images, with minimal or no vasogenic edema. Linear internal enhancement or partial rim enhancement was seen in three of the four cases and no enhancement in one case. The three intraaxial masses demonstrated dense calcification on CT while dense calcification also was noted on the diagnostic angiogram in the fourth case. Preoperatively, the intraaxial lesions were thought to represent cavernomas or densely calcified neoplasms based on their CT and MR appearance.

CONCLUSION
Calcifying pseudoneoplasms of the neural axis are rare non-neoplastic lesions that may mimic more common calcified vascular lesions such as cavernoma or neoplastic masses such as oligodendroglioma, ganglioglioma or meningioma. The marked uniform T1 and T2 hypointensity on MR imaging and dense calcification on CT are typical and should raise the possibility of this entity. When extraaxial, the lack of solid enhancement may help distinguish from meningioma. When intraaxial, the T2 hypointensity may help to suggest this diagnosis when considering calcifying neoplasms such as oligodendroglioma and help differentiate this lesion from a cavernoma which has a more typical “popcorn” appearance of calcification and often has central T2 hyperintensity.

KEY WORDS: Calcifying pseudoneoplasms, fibro-osseous lesions

Poster 108
MR Imaging and Grading of Brain Tumors: Prognosis of Patient Survival
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PURPOSE
We studied magnetic resonance imaging (MRI) evaluation as a tool for predicting survival in patients with brain tumors in comparison with histologic diagnosis.

MATERIALS & METHODS
Two neuroradiologists evaluated the diagnostic MRIs of 244 patients with brain tumors being admitted from 1994 to 1998. They were blinded to any clinical information and graded all brain tumors into benign and malignant based on standardized criteria. Independently, histologic diagnosis from biopsy or open surgery and the clinical follow up of up to 12 years were assessed. MR imaging was performed on 1.0 and 1.5 T MRI machines with T2- and T1-weighted spin-echo sequences before and after contrast injection using all three planes in almost all cases.

RESULTS
Based on MRI, 226/244 brain tumors (93%) were regarded as malignant and 18/244 (7%) as benign. Based on histology, 201/244 brain tumors (83%) were classified as malignant, 23/244 (9%) as benign, and histology remained indecisive in 20 patients (8%). Patients with malignant brain tumors classified by MRI had a mean survival time ± standard deviation of 1.24 years (1.24 ± 2.42), based on histology 1.10 years (1.10 ± 1.99). Patients with benign brain tumors classified by MRI had a mean survival time of 6.41 years (6.41 ± 5.06), based on histology of 6.32 years (6.32 ± 5.17). Patients with concordant diagnosis of malignant brain tumor according to MRI criteria and histology (192/244, 78%, mean survival time of 0.96 ± 1.73 years) had a shorter survival compared to patients with concordant diagnosis of benign brain tumors (9/244, 4%, mean survival time of 8.80 ± 4.90 years). The remaining 43/244 patients had discordant diagnoses based on MRI and histology: MR imaging diagnosis benign and histologic diagnosis malignant (9/244, 4%, mean survival time of 4.02 ± 4.19 years), MR imaging diagnosis malignant and histologic diagnosis benign (14/244, 6%, mean survival time of 4.72 ± 4.85 years) and MRI diagnosis malignant and histologic diagnosis indecisive (20/244, 8%, mean survival time of 1.48 ± 3.66 years). The analysis of the different brain tumors concerning type and grade showed the best agreement between MRI diagnosis, histologic diagnosis and survival time in glioblastoma multiforme (MRI 107/244, 44%, mean survival time 0.90 ± 1.65 years; histology 96/244, 39%, mean survival time 0.82 ± 0.93 years).

CONCLUSION
MR imaging and histologic evaluation allow for a similarly good prediction of survival in patients with benign and malignant brain tumors.

KEY WORDS: MRI, brain tumor, prognosis and survival time

Poster 109
Comparison of Enhancing Fraction with Blood Volume and Contrast Transfer Coefficient in Cerebral Glioma
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PURPOSE
Dynamic contrast-enhanced MRI (DCE MRI) requires the use of tracer-kinetic modelling to produce estimates of contrast transfer coefficient (ktrans), blood volume (vb), and
extravascular extracellular volume ($v_e$). A simpler measure of bulk tumor perfusion, enhancing fraction, has been proposed, measuring the proportion of voxels with evidence of enhancement following contrast agent administration. It does not quantify enhancement intensity, but identifies the presence of measurable perfusion. In low-grade gliomas, vessel permeability is low and the blood-brain barrier (BBB) is intact; therefore contrast agent remains within the vascular space. In high-grade gliomas there is disruption of the BBB and marked leakage of contrast agent into the extravascular space. The aims were to examine how enhancing fraction related to $K_{trans}$, $v_p$, and $v_e$ in gliomas of different grade.

**Materials & Methods**

Thirty-six glioma (14 grade II and 22 grade IV) were imaged (3.0 T Philips Achieva MR scanner), prior to surgery. The DCE MRI protocol consisted of baseline $T_1$ measurement (variable flip angle 3D $T_1$-FFE) followed by 3D $T_1$-FFE volumes acquired every 3.4 seconds. Tumor volumes of interest were defined on the anatomical images. Postprocessing was performed with in-house software generating measurements of enhancing fraction and DCE MRI parameters; $K_{trans}$, $v_p$, and $v_e$. Voxels were identified as enhancing if a measure of the initial area under the contrast agent concentration curve was greater than zero. Histologic grade and median values of DCE MRI parameters were compared with measurements of enhancing fraction.

**Results**

Enhancing fraction did not differentiate between grade. In grade II tumors, enhancing fraction correlated with $v_e$ ($p<0.0005$, rho=0.81, Fig 1a) but not $K_{trans}$ ($p=0.39$) or $v_p$ ($p=0.13$). In grade IV tumors enhancing fraction correlated with $K_{trans}$ ($p=0.008$, rho=0.55, Fig 1b) but not $v_p$ ($p=0.35$) or $v_e$ ($p=0.11$).

**Conclusion**

The sensitivity of this technique in assessing enhancement is greater than that of a human observer using conventional radiologic criteria and may account for the failure of enhancing fraction to distinguish between grade II (conventionally “nonenhancing”) from grade IV (classically “enhancing”) gliomas. The results suggest that enhancing fraction may be a potential surrogate for DCE MRI parameters, reflecting $v_p$ in grade II and $K_{trans}$ in grade IV gliomas. Previously $v_e$ has shown correlation with histologic subtype and genotype in low-grade tumors, whilst $K_{trans}$ has shown correlation with survival in high-grade tumors. Enhancing fraction may carry similar genetic, histologic and prognostic information, with the advantage of being a more simply derived measure.

**Key Words:** Glioma, DCE-MRI, enhancement

**Poster 110**

**Upgrading Brain Tumors Radiotherapy Planning Using an Automatic Registration of Preoperative MR Imaging Study with Postsurgical CT Study**

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**Purpose**

To improve radiotherapy planning of brain tumors, following complete or incomplete surgical resection.

**Materials & Methods**

Three-dimensional planning radiotherapy for brain tumors usually performed on a dedicated CT study using a mask. In patients who underwent removal of the brain tumor the definition of the planning target volume for radiotherapy is based on preoperative MRI study. A new method based on software package (Carestream Health, Rochester, NY) allows automatic registration of MRI to CT studies with local emphasis on the target area. This allows the physician to prescribe effectively the exact boundaries of the radiotherapy and reduce the time needed for the radiotherapy. Total of 15 patients with a solitary primary or secondary brain tumor and were referred for brain irradiation, were included in this study. All patients had initial cerebral MRI examination and underwent postsurgery CT scan for radiotherapy planning. Routine manual registration of the pre and postsurgical studies was done for all patients and was used for the actual treatment. Rigid 3D Registration Algorithm Outline includes a morphologic filter that extracts the patient’s body and eliminates external objects, such as the scanner bed. The images are iteratively filtered and resampled to form a hierarchy of 3D images of decreasing data volume and spatial resolution. The cost minimization starts at the top (low-resolution) level and proceeds downwards. The top levels contain relatively small amounts of data, which allows for an exhaustive search for the optimal displacement in $X$, $Y$, and $Z$ directions (i.e., cost function is calculated for all displacements within imposed limits). After completion of the initial registration based on a 3 degrees of freedom (DOF) search, the cost minimization is extended to 6 DOF (i.e., displacements in $X$, $Y$, and $Z$ directions, as well as rotation angles around $X$-, $Y$-, and $Z$- axes). After the minimum is found at a certain resolution level, the algorithm continues the search at the next level, until it reaches the bottom of the image pyramid. Automatic MRI to CT registration was performed on all data sets. Comparison between the results of the two data sets was conducted.
RESULTS
Automatic registration of the two data sets: preoperative MRI and postoperative CT was successful for all 15 patients. Time needed for completion of the automatic registration was less than 5 seconds compared with over 12 minutes for a trained technician to perform manual registration. There was concordance between the two methods in all 15 patients. Manual registration is operator-dependent and can alter from one user to another based on the selection of the corresponding fiduciaries on both datasets.

CONCLUSION
The new method improves the consistency of registration of the pre MRI and postsurgical CT examination for radiotherapy planning while almost eliminating the time needed.

KEY WORDS: Three-dimensional planning radiotherapy, MRI to CT registration

Poster 111
Assessment of Brain Tumor Perfusion with Multiphase Pulsed Arterial Spin Labeling at 3 T MR Imaging: Comparison with Dynamic Susceptibility-Weighted Contrast-Enhanced MR Imaging

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PURPOSE
The purpose of this study was to determine whether a multiphase pulsed arterial spin labeling (multiphase PASL) technique provides similar information about brain tumor perfusion compared to dynamic susceptibility-weighted contrast-enhanced (DSC) MR imaging.

MATERIALS & METHODS
Twenty-two patients with histologically proved brain tumors (low-grade gliomas: n=5, high-grade gliomas: n=14, metastatic brain tumors: n=3) were examined prospectively at 3.0 T MRI. The multiphase PASL images were acquired using multiphase single-shot EPI by the Look Locker method (10 phases, phase interval=250ms, dynamic scans=40). At each phase, a pair of nonlabeled and labeled images was acquired, and a perfusion-related arterial spin labeling image was created by subtracting the labeled image from the nonlabeled image. After multiphase PASL data acquisition, a T2*-weighted first-pass bolus perfusion study was performed using a gradient-echo type single-shot EPI. Two neuroradiologists independently chose an image of having maximum perfusion of the tumor compared to the normal brain tissue among the multiphase PASL images, and graded the tumor perfusion using a 4-point grading system: grade 3, higher than the contralateral cortex; grade 2, equivalent to the contralateral cortex; grade 1, equivalent to the contralateral white matter; and grade 0, lower than the contralateral white matter. The maps of relative cerebral blood volume (rCBV) were computed from DSC data, and the maximum rCBV of the tumor were graded using the same grading system as multiphase PASL images. The ratio between the maximum rCBV of the tumor and the rCBV of the contralateral white matter (as the normalized maximum rCBV ratio) also was obtained from DSC data. Kappa analysis of interobserver agreement on each technique, and an agreement for grading of maximum perfusion between multiphase PASL and DSC techniques were performed. The correlation between grading of the maximum perfusion on multiphase PASL images and the normalized maximum rCBV ratio was determined by Spearman correlation coefficient test.

RESULTS
Interobserver agreement was good for multiphase PASL (kappa 0.79) and excellent for DSC (kappa 0.85). Agreement for grading of maximum perfusion between two techniques was good (kappa 0.78 for one neuroradiologist, 0.71 for second neuroradiologist). The maximum perfusion on multiphase PASL images correlated well with the normalized maximum rCBV ratio (r=0.87, P<0.0001 for one neuroradiologist, r=0.81, P<0.0001 for second neuroradiologist).

Fig. Multiphase PASL image in patient with glioblastoma shows higher perfusion of tumor compared to normal cortex.

CONCLUSION
The multiphase PASL technique provides similar information about brain tumor perfusion compared to DSC technique.

KEY WORDS: Arterial spin labeling, brain tumor
Characterization of Central Nervous System Metastatic Melanoma: A Comparison between 3 T and 7 T MR Imaging

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Purpose
Early detection and accurate characterization of central nervous system metastatic melanoma are important to proper patient management. At lower field strengths, these tumors often produce the characteristic appearance of hyper-intense T1 and hypo-intense T2 signals on noncontrast MRI that has been shown to be related to high melanin content (melanotic) and hemorrhage (1, 2). Metastatic melanoma tumors containing low concentrations of melanin (amelanotic) appear as hypo/isointense T1 and hyper/isointense T2 lesions (1, 2). The objective of our study was to compare brain images of patients with CNS metastatic melanoma using 3 T and 7 T MRI. We hypothesize that the increased sensitivity, higher resolution and additional contrast mechanisms [e.g., susceptibility-weighted imaging (SWI)] available at higher field strengths may offer advantages when screening for CNS metastases in patients diagnosed with melanoma.

Materials & Methods
Seven patients with known metastatic melanoma underwent evaluation at both 3 T and 7 T using field strength adjusted noncontrast-enhanced T1-, T2-, T2*- and SWI. Postcontrast images also were obtained from each patient at 3 T.

Results
A total of 10 tumors were identified in three patients. Of these tumors, six demonstrated melanotic appearance (hyperintense T1 and hypointense T2) and were equally detectable in noncontrast images obtained at both field strengths. The four remaining tumors demonstrated amelanotic signal pattern (hypo/isointense T1 and hyper/isointense T2). Two of these tumors were observed at both 3 T and 7 T. Importantly, two amelanotic tumors only were detectable following contrast administration at 3 T, but were visible at 7 T without the addition of contrast. No tumors were detected at 3 T that were not also observed at 7 T.

Conclusion
Both melanotic and amelanotic metastatic melanoma CNS tumors are detectable at 3 T and 7 T. Studies obtained without the use contrast at higher field strengths are able to resolve amelanotic melanoma lesions requiring contrast at lower field strengths.

References

Key Words: 7 T, melanoma, metastases

Clear Cell Meningioma: Intracranial Porphyry?

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Purpose
Clear cell meningioma (CCM) is a rare meningioma subtype with less than 50 cases reported in the literature. This entity is important clinically, being characterized as a WHO grade II tumor with a more aggressive clinical course and increased local recurrence rate after total resection (up to 60%). We report on a series of 11 histologically proved cases of CCM imaged at our institution which, to the best of our knowledge, represents the largest series to date in the radiology literature and the second largest such series overall.

Materials & Methods
This a retrospective review of the radiologic and pathologic data base at our institution over the past 8 years for all histologically proved cases of clear cell meningioma. We report on the clinical, pathologic, and radiologic features with particular emphasis on imaging characteristics. We examine specific imaging patterns and morphology including signal characteristics on T1, T2, FLAIR, and contrast-enhanced images, tumoral margins, location, distribution, and disease extent.

Results
Many of the cases of CCM demonstrate imaging characteristics similar to those of typical meningiomas. However, at least one third of all cases of CCM encountered at our institution showed unusual imaging features including lobulated margins, heterogeneous enhancement, and most intriguingly, cystic internal architecture without incomplete FLAIR suppression. The latter imaging appearance resembles large grained crystals dispersed in solid enhancing matrix, similar to porphyry. We surmise that this appearance may be related to a glycogen and hyaline rich histologic composition. The presence of any or all of these imaging findings may be suggestive of the diagnosis of clear cell meningioma.

Key Words: CCM, meningioma, porphyry
CONCLUSION
Clear cell meningioma is a rare histologic subtype of meningioma. Certain imaging features may represent clues to a specific diagnosis, leading to better disease management.

KEY WORDS: Clear cell meningioma, meningioma, brain

Poster 114
Measurements of Velocity, Wall Shear Stress and Pressure Differentials in Arteriovenous Malformations Using a Novel 7D Contrast-Enhanced MR Angiography Technique with an Acceleration Factor of 300

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PURPOSE
To generate highly accelerated 7D images (HYPR FLOW) that encompass the entire brain and display: 1) a temporal series with a reconstruction window of 0.75 seconds for each 3D volume, 2) maps of velocity, wall shear stress and pressure gradients.

MATERIALS & METHODS
We introduce a novel imaging method (HYPR FLOW) that dramatically accelerates contrast-enhanced time-resolved MRA and also encodes for velocity. The conventional Cartesian readout is replaced by an undersampled spherical readout and image data are processed using the recently developed highly constrained backprojection with local reconstruction (HYPR LR). Following contrast injection (2-3mL/s, 0.1 mm/kg) a time series of 3D whole brain images are obtained followed by 300 seconds of phase contrast velocity encoding. The acquisition uses an undersampled spherical readout (VIPR) that provides an acceleration factor of 300. The data are processed using (HYPR-LR) that takes advantage of the redundancy of information in a time series. The result is a series of images with high temporal, high spatial resolution and velocity encoding. HYPR FLOW exams were obtained in seven volunteer subjects and seven patients with brain AVMs. Parameters for the dynamic series were: TR/TE = 3.1/0.4 ms, temporal reconstruction window of 0.75 seconds. Parameters for the velocity encoding were: FOV = 20x20x20cm³, TR/TE = 12.5/4.8 ms, 300 sec. Total imaging time 350 seconds. Three-dimensional HYPR FLOW velocity data were used for the generation of 3D maps of shear stress, vector plots and pressures gradients using the Navier-Stokes equations.

RESULTS
This is the first report of whole brain in vivo measurements of wall shear stress in AVMs. Our results indicate that wall shear stress is increased in the arteries that directly supply the AVM. Pressure is reduced in the major feeding arteries relative to normal contralateral arteries and flow volume is increased. Quantitative measure of the contrast kinetics demonstrated that HYPR LR processing maintained the true dynamic properties of the contrast bolus. Signal to noise for HYPR FLOW was preserved (51.2) even at a spatial resolution of 0.31mm³. Two frames from the HYPR FLOW demonstrate the arterial and venous components of the AVM - note the differential filling of the transverse sinuses (arrows).

CONCLUSION
We have shown that an acceleration factor of 300 can be achieved by radial undersampling (VIPR) and reconstruction using HYPR-LR. Furthermore, velocity encoding permits the derivation of clinically valuable maps of speed, pressure differentials, and shear stress.

KEY WORDS: Acceleration, MRA, arteriovenous malformation
Poster 115

Ultrahigh Field Susceptibility-Weighted Imaging Venography at 7 T

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PURPOSE

Susceptibility-weighted imaging (SWI) is a velocity-compensated 3D gradient-echo sequence which enhances T2* contrast from local susceptibility differences in tissue through phase imaging (1,2). By exploiting the magnetic susceptibility of deoxyhemoglobin, SWI provides high-resolution venographic images. This study aims both to demonstrate dramatically improved SWI venography at 7T versus 3T and to evaluate parameters yielding optimal visualization of venous structures at 7T versus 3T.

MATERIALS & METHODS

Four volunteers were scanned on 3T and 7T whole-body MR systems using a 24-element head coil array with a birdcage-like circularly polarized transmit coil and 24 element phased array at 7T and a 12-channel array head coil at 3T. TR, TE, BW and FA varied from 30-45ms, 13-26ms, 80-140Hz/pixel and 10-25° respectively. Slice thickness ranged from 600µm-1mm for 7T and 1-2mm for 3T with in-plane resolution from 215-430µm. A high-pass filter of 64 and 4X phase multiplication factor were applied. Evaluation was based on SWI magnitude, phase and minimum intensity projection (mIP).

RESULTS

Both signal-to-noise ratio (SNR) and contrast-to-noise (CNR) are markedly increased for SWI venography at 7T versus 3T (Figure). 7T venography allows thinner slices and higher resolution. Best contrast is at TE = T2* of venous blood: TE=17 for 3T; TE=14 for 7T. Optimal flip angle is roughly 20° at 3T and 15° at 7T. Qualitatively, 7T SWI venography depicts venules with greater conspicuity (Figure).

Figure. Optimized SWI in healthy volunteer with representative SWI phase images at 3T (mIP image with TR/TE/Flip angle of 45ms/25ms/20°; slice thickness of 2mm; 4 slices; in plane resolution 430µm) (A) and 7T (mIP image with TR/TE/Flip angle of 45ms/16ms/20°; slice thickness of 1mm; 8 slices; in plane resolution 215µm) (B). Numerous venules are depicted on 7T versus 3T. Three-dimensional venography from 7T whole slab imaging generated through venous blood pixel quantification (C).

CONCLUSION

The capability of SWI venography to detect and distinguish small veins in the brain appears significantly improved at 7T due to substantial SNR increase and venous blood susceptibility contrast at ultrahigh fields. High quality venography has implications for discriminating subtle abnormalities in central nervous system vascular pathology.

REFERENCES


KEY WORDS: Susceptibility-weighted imaging, venography, ultrahigh field

Poster 116

Visualization of Anterior Spinal Artery and Adamkiewicz Artery Using Dual Source CT: Correlation with Tube Voltage

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PURPOSE

To assess the conspicuity of anterior spinal artery (ASA) and artery of Adamkiewicz (AKA) on CT angiography by different voltage using a 64-slice dual source computed tomography (DSCT) scanner.

MATERIALS & METHODS

Twenty-three consecutive cases (mean age 72.1 years) with aortic aneurysm underwent DSCT (Somatom Definition, Siemens Medical Solutions) angiography. Iopamidol (370 mg/ml iodine, 100 ml) was injected at rate of 4 ml/s. Early arterial phase images were obtained by bolus tracking method. By dual energy system, images by two tube voltage (80kV and 140kV) were obtained simultaneously. Fused images of 100kV and 120kV tube voltage were reconstructed on a workstation (Syngo Dual Energy software, Siemens Medical Solutions). Visualization of ASA and AKA were qualitatively investigated on multiplanar reformation images as follows: (1) Visualization of ASA; assessed as length of visualization by vertebral body (VB); (2) Visualization of AKA; following two points were accessed by 3 grade score method (good, fair and poor); (2a) Visualization of hairpin-shaped union to ASA; (2b) Continuity of AKA from the stem of the intercostal or lumbar artery to ASA.
RESULTS

(1) Length of AKA visualization on average was 3.35 VB lengths on 80kV images, 3.52 VB lengths on 100kV, 3.17 VB lengths on 120kV and 2.39 VB lengths on 140kV. (2a) Visualization of hairpin-shaped morphology of AKA was good in 10 cases, fair in 11 cases and poor on 2 cases on 80kV images. On 100 kV images, they were 11 cases; 10 cases; 2 cases respectively. On 120kV images, they were 11 cases; 10 cases; 2 cases respectively. On 140kV images, they were 3 cases; 13 cases; 7 cases respectively. (2b) The continuity of AKA was obtained as good in 6 cases, fair in 11 cases and poor in 6 cases on 80kV images. While, on 100 kV images, they were 8 cases; 8 cases; 7 cases respectively . On 120kV images, they were 9 cases; 3 cases; 10 cases respectively. And on 140kV images, they were 2 cases; 6 cases; 15 cases.

CONCLUSION

Within voltage range of the current study (80kV-140kV), images by lower voltage provided higher contrast between soft tissue and iodine within arteries, and suffered higher noise at the same time. In the current study, 100kV images depicted ASA most conspicuously and both 100kV and 120kV images seemed to visualize AKA better.

KEY WORDS: Artery of Adamkiewicz, dual source CT

Poster 117

T1 Mapping of Human Brain at 7 T with B1 Correction

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PURPOSE

This work investigates the feasibility of T1 mapping at high field (i.e., 7 T, for brain tissue characterization and anatomic mapping). Challenges include (1) the need to minimize errors from significant B1 inhomogeneities due to dielectric effects at high field and (2) to collect the parametric and B1 correction information in an acceptable scan time.

MATERIALS & METHODS

Parametric T1 maps were calculated for six individuals using a multiple flip angle approach (1) with and without B1 correction using an “actual flip angle” map collected by a pulsed steady state (PSS) acquisition (2).

RESULTS

B1 correction significantly improved the spatial uniformity of the calculated T1 maps. The uncorrected maps displayed a circular pattern similar to the measured B1 map. ROI measurements are shown in the table below for both uncorrected and corrected maps along with recently published values (3). Table. Human brain T1 relaxation times (mean ± standard deviation in msec) measured at 7 T.

<table>
<thead>
<tr>
<th></th>
<th>no B1 correction</th>
<th>with B1 correction</th>
<th>from reference [3]</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSF</td>
<td>403±3875</td>
<td>511±1004</td>
<td>442±137</td>
</tr>
<tr>
<td>Frontal WM</td>
<td>840±51</td>
<td>1429±68</td>
<td>1220±36</td>
</tr>
<tr>
<td>Frontal Cortical GM</td>
<td>1350±126</td>
<td>2530±198</td>
<td>2132±103</td>
</tr>
<tr>
<td>Putamen</td>
<td>1094±109</td>
<td>1880±166</td>
<td>1700±66</td>
</tr>
<tr>
<td>Thalamus</td>
<td>1097±205</td>
<td>1973±157</td>
<td>1656±84</td>
</tr>
<tr>
<td>Caudate</td>
<td>144±137</td>
<td>2089±108</td>
<td>1745±64</td>
</tr>
<tr>
<td>Globus Pallidus</td>
<td>1187±103</td>
<td>1668±73</td>
<td>1347±52</td>
</tr>
</tbody>
</table>

CONCLUSION

T1 mapping at 7 T that includes correction for B1 inhomogeneity produces values which are similar to previously published measurements. Parametric fitting to multiple flip angle measurements while also accounting for flip angle variation using an acquired B1 map is a promising approach for quantitative T1 estimates of human brain tissue at 7 T.

REFERENCES


KEY WORDS: 7 T, T1 mapping, B1 correction
Poster 118

ExamCard v2 for Anatomical Imaging of Human Brain at 7 T

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PURPOSE
Continual development of a clinical protocol optimized for neuroimaging of CNS pathologies at 7 T.

MATERIALS & METHODS
Studies were performed on a Philips Achieva 7 T whole body MRI scanner (Philips Medical Systems, Cleveland, OH, USA) with a volume transmit/16-channel receive head-coil (Nova Medical Inc., Wilmington, MA, USA). More than 40 individuals have been scanned in a number of slice orientations with multiple sequences that have included: 3D T1W turbo field echo (TFE), multi-slice gradient and spin echo (GRASE), multi-slice fast field echo (FFE), 3D susceptibility-weighted imaging (SWI), as well as with B0, B1, and T1 mapping protocols. Sequences were reviewed weekly and iteratively modified to achieve improved spatial resolution, improved tissue contrast, increased apparent SNR, or decreased imaging time.

RESULTS
Initial development began on 12 healthy male subjects, and has continued with inclusion of patients with such pathologies as MS, melanoma metastatic to the brain, and hippocampal pathology. Initial results confirm the need for careful consideration of the impact of B1 and B0 inhomogeneities on image contrast and uniformity when using standard T1- and T2-weighted sequences. These factors, together with the static-field-dependent increase in T1 and decrease in T1 dispersion, T2 and T2*, require significant modifications to standard imaging parameters (e.g., increased TR, decreased TE) to achieve acceptable contrast. Further sequence modifications were required to maintain SAR within acceptable limits. With these considerations in mind, our current protocol currently includes: 3DTFE (0.7 mm x 0.7 mm x 0.7 mm; TR/TE = 5.3/2.4 ms; SENSE factor = 2.9; Imaging time 8:58); GRASE (0.5 mm x 0.5 mm x 3.0 mm; TR/TE = 12426/59 ms; SENSE factor = 2.0; Imaging time 5:36); FFE (0.5 mm x 0.5 mm x 3.0 mm; TR/TE = 532/12 ms; SENSE factor = 2.0; Imaging time 4:54). In addition, we have incorporated SWI which shows promise for improved imaging of the venous circulation at 7 T (0.5 mm x 0.5 mm x 1.0 mm; TR/TE = 22/15 ms; SENSE factor = 2.0; Imaging time 4:03). The total scan time for this 7 T neuroimaging protocol, including the B0, B1 and T1 mapping sequences is currently less than 50 minutes.

CONCLUSION
Within the constraints of imaging at 7 T, which include significant B0 and B1 inhomogeneities and SAR challenges, we have begun the process of optimizing a basic set of 7 T pulse sequences for improved SNR, spatial resolution, and contrast resolution within a reasonable imaging time. Clinical Relevance Application: As with the initial human systems at 3 T, imaging efforts at 7 T will require continually refinement of pulse sequences in order to achieve the maximal research and clinical utility of these systems.

KEY WORDS: 7 T, neuroimaging

Poster 119

Bone Segmentation in Intracranial CT Angiography: Bone Subtraction versus Dual Energy

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PURPOSE
CT angiography (CTA) has demonstrated itself as a useful tool for the evaluation of cerebrovascular disease. However with CTA, there have been difficulties in evaluating aneurysms at or adjacent to the level of the skull base. A study has shown that 57% of false negative findings were related to aneurysms located at or near the skull base, though this only contributed to 36% of aneurysms. Bone subtraction CTA (BSCTA) has been reported to improve conspicuity of aneurysm at the skull base. This technique is degraded by any significant patient motion between the prescan and CTA exam. Another approach that recently has become available is dual energy CTA (DECTA). We compared bone segmentation using BSCTA to DECTA in patients scheduled for clinical exams. Our hypothesis was that by elimination of misregistration artifacts, DECTA would be superior to BSCTA for bone segmentation and arterial visibility near the base of skull.

MATERIALS & METHODS
We performed a retrospective analysis of four patients according to the guidelines of the institutional review board. Patients were referred for multiple clinical indications, including evaluation of aneurysms. We initially performed an unenhanced spiral CT (120 kVp, 40 mAs) which allows us to perform the bone removal process. For the dual energy, we used two tubes and two corresponding detectors offset by 90 degrees: detector 1: 140 kVp / 75 mAs and detector 2: 80 kVp / 318 mAs. Postprocessing was done after the data were transferred to a workstation (Leonardo, Siemens Medical Solutions) and processed with prototype software. The data were compared to fused CTA images obtained from the 140 and 80 kVp data sets. Observer was blinded to technique for both the digital subtraction and dual energy CTA source images. Each data set was compared with the fused images separately and evaluated by a survey form, rating the quality of subtraction on a scale of 0-10 with 0-vessel obscured and 10-no artifacts, vessel clearly visible. The subjects were asked to rate each segment of the ICA separately. For this study we used a classification system based on anatomic landmarks (i.e., extracranial, intraosseous, cavernous, clinoïd, and supraclinoïd segments).

RESULTS
Compared with DECTA, BSCTA better demonstrates the intracranial circulation, in particular of the clinoid segment. In the clinoid segment, 21 favored BSCTA, 2 favored the DECTA, and 1 found them equivocal. In the cavernous seg-
ment, 14 favored BSCT A, 8 favored DECTA, and 2 found them equivocal. In the intraosseous segment, 14 favored BSCT A, 8 DECT A and 2 found them equivocal.

CONCLUSION
Using commercially available software, bone segmentation with DECTA is less effective than BSCTA.

KEY WORDS: Aneurysm, bone subtraction, dual energy

Poster 120
Diffusion Tensor Imaging in Alzheimer Disease and Mild Cognitive Impairment: Voxel-Based Analysis with Tract-Based Spatial Statistics

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PURPOSE
Many studies using diffusion tensor imaging (DTI) in mild cognitive impairment (MCI) and Alzheimer disease (AD) have been reported recently. However, the findings are to some extent discrepant. Our purpose was to explore the changes in fractional anisotropy (FA) in subjects with MCI and AD by analyzing DTI data using a sophisticated and reproducible voxel-based approach “the Tract-Based Spatial Statistics (TBSS) method”.

MATERIALS & METHODS
Diffusion tensor imaging data were collected from 17 patients with AD, 28 subjects with MCI and 18 healthy controls. Voxel-based analysis with TBSS was used to compare FA among the three groups.

RESULTS
An extensive number of fiber tracts showed decreased FA in both MCI subjects and AD patients compared with control subjects. Abnormal tracts included: the perforant pathway, cingulum, uncinate fasciculus, inferior and superior longitudinal fasciculus, corpus callosum, thalamic radiation, fornix, tracts in brain stem, and cerebellar tracts. However, in the AD patients the changes in FA were more pronounced and covered larger areas. The changes in FA were present asymmetrically or were more severe in the right hemisphere than in the left hemisphere in MCI subjects or AD patients in the following tracts: the perforant pathway, thalamic radiation in the anterior limb of the internal capsule, anterior arch of fornix, frontal part of the superior longitudinal fasciculus, and fibers connecting the substantia nigra. The parietal part of superior longitudinal fasciculus was affected more severely on the left than on the right side in MCI subjects.

CONCLUSION
Tract-Based Spatial Statistics is a powerful method in examining the degeneration of neurofiber tracts in MCI and AD patients. Degeneration extensively involves neurofiber tracts already in the early phase of AD, and progressively deteriorates. The tracts degenerate asymmetrically in some structures.

KEY WORDS: Alzheimer disease, diffusion tensor imaging, mild cognitive impairment

Poster 121
Automated Evaluation of Brain Atrophy Based on MR Imaging: Clinical Experience

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PURPOSE
Common presentations of various neurodegenerative diseases on MRI include focal or diffuse brain tissue losses and an increased volume of the subarachnoid spaces. The typical patterns of atrophy in normal aging brain and neurodegenerations have been studied extensively using methods such as voxel-based morphometry. Although these methods provided invaluable information on the diseases processes, their use in clinical practice remains limited because of the necessity of homogeneous group of patients. In the present work we report on the use of fully automated image analysis system integrated into the daily clinical routine, which allows for thorough evaluation of brain atrophy for each individual patient.

MATERIALS & METHODS
The past 9 months, 130 patients were analyzed using the present automated assessment of the brain atrophy. High-resolution 3D magnetization prepared T1-weighted images (1) with good contrast between gray (GM) and white matter (WM) were acquired on one of our Philips clinical MR systems (three 1.5T or 3T) using the parameters adjusted for the
RESULTS
In our four dementia cases associated with Lewy bodies we observed in each subject a global WM and GM loss, a significant atrophy of pallidum and trend towards significant atrophy of thalami, caudate, hippocampus, and amygdala. Significant reduction of the cTHK was found in orbito-frontal, prefrontal, parietal and occipital cortices, but preserved in temporal lobes. The cFD followed a similar pattern, except for temporal lobes where it was altered also. In three patients with an amnesic mild cognitive impairment, analysis identified a trend towards significant atrophy of the cerebellar cortex with minor focal atrophy of the deep nuclei, and normal cTHK. However, the cortical folding patterns in medial orbito-frontal, postcentral, and occipital cortices were altered in these subjects. A sample of three mild Alzheimer patients demonstrated atrophy of the cerebellar cortex, caudate, pallidum, and hippocampus. Although the cortical thickness was completely normal, the folding patterns of the gyri were altered globally, which may suggest an ongoing disease.

CONCLUSION
We present results of an automated system of assessment of the brain atrophy. On a set of consecutive clinical subjects, we show that it identifies pathologic presentations in coherence with previously published literature. Although we need to continue validating the presented approach, it seems potentially clinically helpful by providing valuable morphologic and topologic information.

REFERENCES
2. FreeSurfer; https://surfer.nmr.mgh.harvard.edu/fswiki

KEY WORDS: Atrophy, neurodegenerative disease
Establishing normative flow values for the posterior fossa is an important and necessary prerequisite for the diagnosis of abnormal flow in patients with acute or chronic ischemia and arterio-occlusive disease. This data may be helpful also in the assessment of patients with neurodegenerative diseases of the posterior fossa.

**KEY WORDS:** Posterior fossa, normative circulation, MR perfusion

**Poster 123**

**Reversible Inferior Colliculus Lesions in Metronidazole-Induced Encephalopathy: MR Findings on Diffusion-Weighted Imaging and FLAIR**

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**PURPOSE**

This report is to present reversible inferior colliculus lesions in metronidazole-induced encephalopathy, focusing on diffusion-weighted imaging (DWI) and fluid attenuation inversion recovery (FLAIR) image findings.

**MATERIALS & METHODS**

From November 2005 to September 2007, eight patients (5 males, 3 females) were diagnosed as having metronidazole-induced encephalopathy (age range: 43-78 years). They had been taking metronidazole (total dosage: 45g ~ 120g, duration: 30days ~ 2 months) to treat infection in various organs. Initial MR images were obtained after hospitalization, including DWI (8/8), apparent diffusion coefficient (ADC) map (4/8), FLAIR (7/8) and T2-weighted image (T2WI) (8/8) and follow-up MRIs were performed in five patients at 3 to 14 days after discontinuation of metronidazole administration. Findings of initial and follow-up MRIs were evaluated retrospectively by two neuroradiologists by consensus, focused on abnormal signal intensities, their locations and reversibility of signal changes on follow-up images.

**RESULTS**

Initial MRIs showed abnormal high signal intensities on DWI and FLAIR (or T2WI) at dentate nucleus (8/8), inferior colliculus (5/8), corpus callosum (2/8),pons (2/8), medulla (1/8) and bilateral cerebral white matter (1/8). High signal intensity lesions on DWI and FLAIR/T2WI showed low signal intensity on ADC mapping (3/4), but one patient had hyperintense bilateral dentate nucleus on DWI, ADC mapping and T2WI. Follow-up MRIs in five patients showed complete resolution of abnormal lesions in dentate, inferior colliculus, pons, medulla and persistent corpus callosal lesion in one patient.

**CONCLUSION**

Reversible inferior colliculus lesions could be considered as characteristic for metronidazole-induced encephalopathy as dentate nucleus involvement.

**KEY WORDS:** Inferior colliculus, metronidazole, encephalopathy

**Poster 124**

**Economic and Clinical Benefits of Point of Care Neuro Head CTs**

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**PURPOSE**

To study feasibility, clinical benefits and potential cost savings of point of care portable head CT scanning in an intensive care unit (ICU) environment.

**MATERIALS & METHODS**

Five hundred two noncontrast head CT scans were performed in the Neuro intensive care unit over a 4-month period utilizing a portable head CT unit (NeuroLogical CereTom®). Studies were requested either as follow up to known conditions or to support immediate medical decision-making. So-called “Brain Attack” (acute stroke) patients were excluded from the study. The diagnostic quality, (ability to assess hydrocephalus, subarachnoid hemorrhage or mass effect) was assessed independently by a neurointerventional, neurointensivist and diagnostic neuroradiologist. The 4-month analysis included :a) total number of studies, b) number of staff and full time employees (FTEs) required for these studies, c) average time to perform the study, d) image quality comparison, e) projected increase of fixed scanner capacity as a result of decreased ICU patients.

**RESULTS**

Five hundred two patients were studied and 501 out of 502 patients were considered diagnostic. Fixed scanner capacity increased by 1182 patients.

<table>
<thead>
<tr>
<th></th>
<th>Portable</th>
<th>Routine</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTEs</td>
<td>²</td>
<td>6</td>
</tr>
<tr>
<td>Exam Time</td>
<td>15 minutes reflecting room arrival to room departure.</td>
<td>30 minutes including travel but excluding patient preparation time</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Point of care portable head CTs produce diagnostic images at a significant cost and opportunity savings (2100 FTE hours/year and 1182 incremental slots on fixed scanner), is safer for patients (no traveling), and provides immediate diagnostic results at the bedside.

**KEY WORDS:** Head CT, portable CT, economics
**Poster 125**

**Diffusion Tensor Tractography of Meyer’s Loop in the Cases of Temporal Lobe Resection for Temporal Lobe Epilepsy: Correlation with Postsurgical Visual Field Defect**

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**PURPOSE**
Our purpose was to evaluate the correlation between visual field defect after temporal resection for temporal lobectomy and degree of resection of Meyer’s loop accessed by diffusion tensor tractography.

**MATERIALS & METHODS**
We examined 14 cases who had undergone temporal resection surgery for temporal lobe epilepsy. The cases were classified into four groups based upon postsurgical visual field defect as follows: Group A: no visual field defect; Group B: incomplete defect less than half of upper quadrant; Group C: incomplete defect more than half of upper quadrant; and Group D: complete defect of upper quadrant. Diffusion tensor images were acquired by EPI sequence. Tractographies of Meyer’s loop were drawn and the distance from temporal tip to the anterior limit of Meyer’s loop (TM distance) was measured. Distance from temporal tip to the posterior limit of temporal lobe resection (TR distance) was measured also on postsurgical image. We calculated the extent of resection of Meyer’s loop as distance from the anterior limit of Meyer’s loop and posterior limit of temporal lobe resection (MR distance: TR distance minus TM distance). We accessed following points: (1) Correlation between visual field defect and the TR distance; (2) The interindividual variation of the TM distance; (3) Correlation between visual field defect and MR distance.

**RESULTS**
(1) There was no statistically significant correlation between visual field defect and TR distance (Figure A). (2) Mean TM distance is 36.9 mm. The interindividual variation of the distance ranged from 29.9 mm to 43.3 mm. (3) Mean MR distance was $+4.9$ mm in Group A and $-6.0$ mm in Group B. These minus values mean that there were still spaces between the Meyer’s loop and the resection. While, the mean MR distance was $+4.99$ mm in Group C and $+7.55$ mm in Group D, these plus values mean the lengths of Meyer’s loop resection. There was statistically significant correlation between the visual field defect and MR distance (Figure B).

**CONCLUSION**
In the current study, the range of interindividual variation in the position of Meyer’s loop was as large as $14$ mm. Postsurgical visual field defect could not be predicted by anatomical extent of temporal lobe resection, but could be predicted by presurgical tractography. Evaluation of Meyer’s loop using diffusion tensor tractography prior to surgery seemed to be feasible in prediction of visual field defect after temporal lobe resection and surgical planning.

**KEY WORDS:** Tractography, Meyer’s loop, epilepsy

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**Poster 126**

**Sensitivity-Encoded Proton MR Spectroscopic Imaging at 7 T**

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**PURPOSE**
Magnetic resonance spectroscopic imaging (MRSI) at 7 T promises to provide higher resolution and signal-to-noise ratios (SNR) compared to lower field strengths. However, acquisition times in high resolution, multislice MRSI using conventional phase-encoding can be prohibitively long for clinical studies. This abstract demonstrates the feasibility of scan time reduction using 2D-sensitivity (SENSE) encoded MRSI at 7 T in the human brain.
Materials & Methods
All experiments were performed on a Philips 7 T system located at the Vanderbilt University Institute of Imaging Science, equipped with a 16-channel parallel receiver array/quadrature volume transmit coil (Nova Medical, Wilmington, MA). The maximum transmit field was software limited at 10 μT. Three normal volunteers (24.7±5.1 (mean±st.dev.) years, 1 female) were scanned. After localization and reference images were acquired, field homogeneity was optimized using shim currents up to second order based on field projection measurements. MRSI consisted of a spin-echo pulse sequence with VAPOR water suppression and 6 OVS lipid suppression pulses. Two transverse 15 mm slices (with the lower at the level of the lateral ventricles) were recorded with TR/TE 2000/48 ms, 24x32 matrix size, SENSE 4 (factor of 2 in both the R-L and A-P directions), FOV 172x230 mm, nominal voxel size = 0.77 cm² with a 10 min scan time. Frequency-modulated 90° and 180° pulses of 0.88 kHz bandwidth were used. Minimum TR and TE were limited by specific absorption rate (SAR), and the length of the RF pulses, respectively. B, and transmit B, maps also were collected.

Results
Figure 1 shows representative gray and white matter spectra and metabolic images from one subject. Excellent spectral resolution and SNR were obtained, including the ability to resolve the white matter 2.02 ppm N-acetyl signal into its constituents, NAA and NAAAG. Over the central brain region (20 voxels/subject) the average creatine (Cr) linewidth was 8.95±0.75 Hz and SNR was 26.6±4.9. Only mild spectral contamination from peripheral lipids was noted. Metabolic images of choline (Cho), Cr, NAA, and myo-inositol (mI) showed central brightness, due to wavelength/dielectric effects of the transmit coil, for which no postprocessing corrections were incorporated.

Conclusion
SENSE-MRSI at 7 T shows promise for high-resolution spectroscopic imaging in the human brain while maintaining reasonably short scan times. Further work will be required to extend spatial coverage (more slices) and improve metabolic image homogeneity, as well as to increase RF pulse bandwidth, while remaining within acceptable SAR limits.

Key Words: Brain, spectroscopic imaging, high-field

Poster 127
Image-Guided Transcranial Magnetic Stimulation: Correlation with Magnetoencephalography in Localizing Motor Cortex in Patients with Gliomas

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Purpose
While entire functional networks can be visualized with MEG, fMRI, and PET, no information is gained as to whether these areas play critical roles in the performance of specific tasks or are just merely coactivated. To fully assess brain functionality in order to guide treatment plans, dynamic imaging techniques, in which a clinician temporarily turns on or turns off specific brain areas systematically assessing behavioral outcomes, are crucial. One such active imaging technique is image-guided transcranial magnetic stimulation (iTMS). Given the additional, but complimentary functional information obtained using iTMS in combination with functional imaging, we sought to investigate the accuracy of iTMS in localizing motor cortex in comparison with magnetoencephalography (MEG).

Materials & Methods
Following IRB approval, iTMS was performed for motor cortex localization in a group of five patients (3 female) with brain tumors within or near motor cortex. A 3D T2-weighted sequence was uploaded into a neuronavigational guidance system (Brainsight™). Single pulse iTMS was applied over motor cortex using a figure 8 coil (Magstim). The location of the iTMS coil was displayed in real-time in relation to the patients’ 3D MRI scan within the neuronavigational system. The TMS coil was adjusted until the location that consistently gave the maximal contraction of the contralateral abductor pollicis brevis was identified. This site was labeled within the neuronavigational system. The patients also underwent MEG using a whole-head MEG system (Omega 275, VSM MedTech Ltd.) for the localization of hand motor cortex. For the motor task, subjects performed self-paced unilateral index finger flexion or abduction. MR images, with the iTMS sites of activation labeled, were transferred to the MEG workstations and coregistration was performed based on anatomical and external fiducial landmarks. Linear distances between iTMS- and MEG-identified motor sites were calculated.

Results
Image-guided transcranial magnetic stimulation successfully identified hand motor cortex in all five patients. In three patients, iTMS activation was not localized to a single digit but instead coactivation of adjacent digits also was observed. Magnetoencephalography successfully identified hand motor cortex in four of the five patients. The average distance between iTMS and MEG identified sites of activation was 14.70 mm +/- 10.23 mm.

Conclusion
We conclude that both iTMS and MEG are useful in the preoperative localization of motor cortex even in the presence of adjacent tumor. While MEG provides a sensitive and spe-
cific index of activation of hand motor cortex, iTMS confirms directly motor cortex activation by visualization of corresponding muscular activity.

**KEY WORDS:** MEG, transcranial magnetic stimulation

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**Poster 128**

**Two-Dimensional CSI MR Spectroscopy: A Biomarker for Detection of Radiation-Induced Metabolic Alterations in Normal Brain**

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**PURPOSE**

Irradiation of the brain can cause delayed neurologic complications and deficits in long-term survivors. Late radiation injury is the major, dose-limiting complication of brain irradiation. We hypothesized that changes in metabolic activity in normal cerebral tissue after radiation therapy can be detected by proton spectroscopy prior to any gross anatomical changes.

**MATERIALS & METHODS**

Nine patients (8 men, 1 female, age range 26-74 years, mean 44.5 years) with primary brain neoplasms (1 craniopharyngioma, 3 pituitary adenomas, 1 meningioma, 5 gliomas) treated with radiation therapy (RT) participated in an IRB-approved prospective MRI and 2D CSI MR spectroscopy (MRS) study. MR imaging and MRS were performed prior to RT, and at 1 and 6 months after the completion of RT. The MRI protocol included: sagittal and axial pre and postcontrast-enhanced T1-weighted images, axial T2-weighted FLAIR and T2-weighted images, diffusion-weighted images, and postcontrast T1-weighted coronal images. Two-dimensional CSI MRS was performed on a 1.5 T scanner (LX EchoSpeed, GE Medical Systems) with the following parameters: TE/TR 144/1500 ms, FOV 23, thickness 6 mm, interspacing 1.5 mm, matrix 256x192, scan time 1NEX 4:20 minutes. The region of interest (ROI) was placed centered on the tumor and included normal-appearing white matter on both sides of the tumor. The metabolic spectra were analyzed using the individual vendor software (Funtool 2, GE) with manual adjustment of metabolic peak boundaries. Small volumes of interest (VOI (100mm³)) were placed systematically to cover the whole ROI and the metabolic ratios NAA/Cr, Cho/Cr and NAA/Cho were calculated. Student’s t-test was used for statistical analysis with a p value of < 0.05 used for statistical significance between values obtained at the preradiation study and those obtained postradiation.

**RESULTS**

There were significant decreases in the metabolic ratios NAA/Cr and Cho/Cr at 1 month and at 6 months after RT compared to values obtained pre RT (p < 0.05). The NAA/Cr ratio decreased from 1.39 (±0.05) (mean ±SE) of the pre RT value to 1.21 (±0.04) 1 month after RT and to 1.13 (±0.04) 6 months after RT. Similarly, the Cho/Cr ratio decreased from 1.39 (±0.04) of the pre RT value to 1.11 (±0.04) 1 month post RT and 1.11 (±0.04) 6 months post RT. The change in the ratio NAA/Cho was not significant (p > 0.05).

**CONCLUSION**

Our initial data in this prospective study suggest that occult injury to the normal brain occurs as early as 1 month after treatment and continues for at least 6 months. The decrease in NAA/Cr ratios over time is suggestive of neuronal damages. This study also shows that MRS is sensitive for early detection of metabolic changes in normal brain tissue undergoing radiation. The use of MR spectroscopy might offer a window of opportunity for intervening therapy to minimize neurotoxicity and neurologic deficit.

**KEY WORDS:** MR spectroscopy, radiation-induced injury

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**Poster 129**

**Quantitative Analysis of Diffusion Tensor Image Quality Using Parallel Imaging Techniques Comparing High-Field 1.5 T and 3.0 T MR Systems**

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**PURPOSE**

The aim of our study was to apply a methodical approach for quantitative evaluation and analysis of image quality of diagnostic DT imaging using parallel MR imaging (MRI) acquisition methods (PAT) on 1.5 T and 3.0 T MR scanners.

**MATERIALS & METHODS**

We examined prospectively 31 healthy volunteers (16 female, 14 male, mean age 34 years) on a 1.5 T MR scanner and a 3.0 T scanner of the same manufacturer. Standardized diffusion-weighted images were acquired with a spin-echo EPI sequence and two different voxel sizes (1.8 x 1.8 x 3.6 = 11.7 mm³ and 2 x 2 x 2 = 8 mm³) as well as three different numbers of signal averages (NSA) of 8, 4 and 2 using comparable sequence parameters at both magnetic field strengths. PAT using GRAPPA reconstruction with acceleration factors of 2 and 3 was applied. These acquisitions were repeated twice to assess the local noise level from difference images. The ROI-based quantitative analysis was performed with on-board tools of the MR scanners by positioning ROIs into three different brain areas. Mean value, standard deviation and number of pixels were calculated for each ROI. Two blinded radiologists independently performed the ROI positioning and evaluation. Signal-to-noise ratios (SNR) were calculated based on the standard deviation in the difference image for each ROI, thus taking into account the inhomogeneous noise distribution of PAT acquisitions. Kappa test was applied for quantification of interobserver agreement.

**RESULTS**

Normalized to the SNR of the anisotropic 11.7-mm³ measurement with 8 averages at 1.5 T, 178.2% of this SNR was found for the same sequence at 3 T. Signal to noise ratios for the sequences with 2 averages were significantly different with 50.8% for 1.5 T and 94.1% for 3 T respectively. For
acquisitions with isotropic resolution and 4 averages, the corresponding values were 49.9% at 1.5 T and 95.2% at 3 T. Interobserver agreement was very good (0.92).

**CONCLUSION**

Diffusion tensor imaging at 3 T delivers better image quality in terms of SNR compared to 1.5 T. The same SNR as at 1.5 T can be obtained with increased isotropic resolution and reduced scan time (4 averages instead of 8 averages) at 3 T.

**KEY WORDS:** Diffusion tensor imaging, SNR, 3 T

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**Poster 130**

**Initial Prodromal State of Psychosis: Gray/White Matter Volume and Diffusion Tensor Data Analysis**

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**PURPOSE**

The clinical care of patients with first episode psychosis is often delayed or inadequate. Moreover, the period of untreated psychosis is a risk factor for a poor outcome. Our hypothesis was that statistical analyses of quantitative MRI data could be a useful biomarker in the early course of psychosis. Thus, this study aimed to identify persistent morphologic changes, mean diffusivity (MD), and fractional anisotropy (FA) in the patients in the initial prodromal state of psychosis (IPSP).

**MATERIALS & METHODS**

Twenty-three patients, who met all the criteria in DSM-IV category for schizophrenia excluding the duration of the disease (less than 6 months of follow up), were examined with MRI at an initial check-up. Twenty-two of 23 finally were diagnosed as schizophrenia at 6 months follow up, and included in this study as having been in the IPSP. Eighteen healthy volunteers also underwent MRI as age-matched controls. The three-dimensional spoiled gradient recalled acquisition with steady state (3D SPGR) and diffusion tensor imaging (DTI) were performed at 3 T MR system (Signa EXCITE 3 T; GE Medical Systems) for all the patients and controls. Image processing for voxel-based morphometry (VBM), a fully automatic technique for computational analysis of differences in regional brain volume throughout the entire brain, was conducted using SPM5 (Statistical Parametric Mapping 5). The parameter of the normalization used in the step of the spatial normalization of the 3D SPGR images in native space onto the customized T1 template was applied also to the coregistered FA map. The normalized FA maps were smoothed with a 6 mm isotropic Gaussian kernel, and a mean image (FA template) was created. Then, all FA maps in native space were transformed onto the stereotactic space by registering each of the images to the customized FA template. Statistical comparison between the two groups was tested using SPM5. Age and sex were treated as confounding covariates.

**RESULTS**

Compared with control subjects, the patients in the IPSP demonstrated a significant increase in MD of the anterior cingulate gyrus (FDR corrected P < 0.05) (Figure; arrows). With regard to gray/white matter volume and FA, no significant difference was observed in the correlation.

**CONCLUSION**

An increase of MD in the anterior cingulate gyrus might represent an early biomarker for the IPSP.

**KEY WORDS:** Schizophrenia, VBM, DTI

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**Poster 131**

**Reliability of Clinical 1H Spectroscopic Imaging Measurements of Brain Tumors**

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**PURPOSE**

Experimental studies have shown that robust 2D spectroscopic imaging (SI) protocols can improve the grading of gliomas (1) but the reliability of the SI performance in different regions of human brain under clinical conditions has not been assessed yet.

**MATERIALS & METHODS**

1H MRSI and anatomical imaging was performed on a 3 T clinical scanner (Tim Trio, Siemens, Erlangen, Germany) in 35 patients with previously suspected intracerebral tumors for additional information concerning the location of highest metabolic activity. Conventional imaging protocol consisted of T2-weighted turbo spin-echo (TSE) sequence and contrast-enhanced axial T1-weighted gradient-echo sequence. Automatic adjustments were applied prior to MRSI data acquisition. PRESS (TR/TE 1700/135 ms) sequence proceeded by CHESS water suppression was used for rectangular VOI selection (4-12 cm in both in plane dimensions) excluding skull and subcutaneous tissue contamination.
Sequence parameters included 16x16 elliptical weighted phase encoding steps across a 16x16 cm FOV, slice thickness of 1 cm, 50% Hamming filter and 3 averages. The total acquisition time was less than 7 minutes. Standard deviation of the amplitude and the line width of choline, creatine and total-N-acetyl-aspartate signals were calculated off-line using AMARES (2) as implemented in jMRUI (3). Spectral quality was assessed by relative SD and the line width of the creatine signal. Relative SD of creatine amplitude higher than 50% was considered as a threshold of poor quality of the spectra. Means of relative SDs, line-widths and percentage of poor quality spectra ± respective SD from 16–70 evaluated voxels per patient are given in the results.

RESULTS
In general, SI measurements yielded reliable data in the FOV positions above (n = 13) and in the height (n = 12) of lateral ventricles, with data quality enabling the calculation of reliable metabolic maps. Poor shim, big susceptibility changes and resulting problems with water signal suppression compromised data quality from the regions below lateral ventricles (n = 10). Only three of these ten measurements (all occipitally) provided data suitable for calculating reliable metabolic maps. Summary of evaluated spectral parameters is given in the table.

Table. Relative SD and line width of Cr signal (3.05 ppm) as calculated by AMARES.

<table>
<thead>
<tr>
<th>Position</th>
<th>n</th>
<th>Rel SD [%]</th>
<th>LW [Hz]</th>
</tr>
</thead>
<tbody>
<tr>
<td>above ventricles</td>
<td>13</td>
<td>18 ± 7</td>
<td>6 ± 1</td>
</tr>
<tr>
<td>lateral ventricle</td>
<td>12</td>
<td>30 ± 10</td>
<td>8 ± 3</td>
</tr>
<tr>
<td>basal occipital</td>
<td>3</td>
<td>19 ± 5</td>
<td>8 ± 1</td>
</tr>
<tr>
<td>basal temporal</td>
<td>7</td>
<td>90 ± 40</td>
<td>18 ± 12</td>
</tr>
</tbody>
</table>

CONCLUSION
Routine SI measurement protocol provides good quality data for the primary and secondary intracerebral tumors. Additional shimming procedure and/or special selection of spectroscopic VOI has to be considered for the SI measurements of meningial tumors and/or lesions near the skull (base).

REFERENCES

KEY WORDS: MRI, spectroscopic imaging, tumor

Poster 132

Sensitivity of T1 FLAIR and T1 Fast Spin-Echo to Detect Enhancing MS Plaque on 3 T

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PURPOSE
To compare postcontrast T1 fluid attenuated inversion recovery sequence to postcontrast T1 fast spin-echo (FSE) in the evaluation of lesion load in clinically proved cases of multiple sclerosis on a 3 T magnet.

MATERIALS & METHODS
At this time we have performed MR imaging in eight patients with multiple sclerosis at 3 T. These exams include axial T2 FSE, and T2 fluid attenuated inversion recovery (FLAIR) as well as pre and postcontrast T1 FLAIR and FSE sequences. Contrast-enhanced sequences were randomized in such a way that in half of the cases T1 FLAIR postcontrast was done first and in the other half it was done after postcontrast FSE sequence, to which it is compared. Time difference between the two sequences is less than 6 minutes. The study presently is going on and more cases will be included in the final evaluation.

RESULTS
In four of the eight patients we found contrast-enhancing lesions on T1 FSE, but only in two of these on T1 FLAIR. Compared with postcontrast T1 FLAIR, there were overall more enhancing lesions seen in the postcontrast FSE sequence.

CONCLUSION
High-field MRI at 3.0 T appear to have a higher detection rate of MS lesions in the postcontrast FSE sequence than on the T1 FLAIR. The enhancement pattern varied with solidly enhancing as well as ring configuration, but the solid enhancement pattern was more common on FSE. If this represents a detection of more chronic, still leaky plaques or true increase in sensitivity to detect active plaques is still not established.

KEY WORDS: MS, 3 T

Poster 133

Prediction Model Using Metabolic Ratios for Classification of New Contrast-Enhancing Lesions in Patients Previously Treated for Primary Brain Tumor

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PURPOSE
Differentiation between recurrent neoplasm and postradiation change in patients who have been treated for primary brain tumors is often difficult based on imaging features alone. The purpose of this study was to assess retrospectively whether MR spectroscopy (MRS) could distinguish between postradiation changes and recurrent brain neoplasm. A prediction model then was developed using the MRS data in order to help determine which patients will require biopsy for definitive diagnosis.

MATERIALS & METHODS
Twenty-nine patients who had undergone treatment for primary brain tumors, in whom routine MR imaging demonstrated new contrast-enhancing lesions at the surgical site or its vicinity prompting MRS evaluation, were studied retrospectively. All patients were examined on a 1.5 T MR scanner (GE Healthcare) and the MRS data were transferred to a separate workstation (Sun, GE Healthcare) for offline post-processing using Functool 2000 software (GE Healthcare). Final diagnosis was assigned using histopathology (n = 10)
or imaging follow up (n = 19, range 2-23 months). For patients classified on imaging findings alone, the shortest follow-up interval for the tumor recurrence group was 2 months and for the radiation change group the imaging follow-up interval for the tumor recurrence group was at least 9 months. Ratios of three metabolites (choline (Cho), creatine (Cr) and N-acetylaspartate (NAA)) were calculated and the results were correlated with the final diagnosis using a Wilcoxon rank-sum analysis. A logistic regression model then was used to create a prediction model based on the most statistically significant metabolite ratio.

**RESULTS**

Significant elevations of the metabolic ratios Cho/Cr (p < 0.001) and Cho/NAA (p < 0.001), as well as a significant decrease in the ratio of NAA/Cr (p = 0.002) were found in patients with recurrent tumor (n = 16) compared to those with postradiation changes (n = 13). A prediction model based on the Cho/NAA ratio yielded a sensitivity of 87.5%, specificity of 84.6% and an area under the receiver operating curve of 0.96. Based on this model, using a Cho/NAA cutoff value of 1.3 would have yielded a 10% posttest probability of tumor recurrence and would have classified correctly all patients with tumor (100%) and nine patients with radiation change (69%).

**CONCLUSION**

Our data show that the elevated Cho/NAA ratio correlated with evidence of tumor recurrence and allowed creation of a prediction rule to aid in lesion classification. The results suggest that MRS may be a useful tool in assigning patients with nonspecific contrast-enhancing imaging findings to either invasive biopsy or conservative clinical management.

**KEY WORDS:** MRS, postradiation, tumor recurrence

**Poster 134**

**Anoxic Injury Associated Cerebral Hyperperfusion Identified with Arterial Spin Labeled MR Imaging**

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**PURPOSE**

Anoxic brain injury is a devastating result of prolonged hypoxia. The goal of this study was to use arterial spin labeling to characterize the perfusion patterns encountered following anoxic injury to the brain.

**MATERIALS & METHODS**

Twelve patients with a history of anoxic injury and ranging in age from 11 to 75 years (mean 49.7) were analyzed with conventional MR imaging and pulsed arterial spin labeling 1 to 13 days (mean 4.9) following anoxic insult. The cerebral perfusion in each case was quantified using pulsed arterial spin labeling (PASL) as part of the standard stroke protocol. Correlation was made between perfusion imaging, conventional imaging, clinical history, laboratory values, and outcome.

**RESULTS**

Eleven of the 12 patients showed marked global hyperperfusion, and one patient showed unilateral marked hyperperfusion. Mean gray matter CBF in these patients was 132.3, ranging from 79.9 to 190.6 (mL/100g tissue/min). Global gray matter CBF was significantly higher in anoxic injury subjects, as compared to controls [F (1,50) = 138.25, p < .001]. Three patients had global hyperperfusion sparing areas of acute infarction. Conventional imaging showed characteristic restricted diffusion in the basal ganglia (n = 8) and cortex (n = 11). Most patients examined expired (n = 10) with only 2 patients surviving at 3-month follow up.

**CONCLUSION**

Pulsed arterial spin labeling can dramatically demonstrate and quantify the severity of the cerebral hyperperfusion secondary to loss of autoregulation of cerebral vascular resistance after a global anoxic injury.

**KEY WORDS:** Arterial spin labeling, anoxic, perfusion

**Poster 135**

**Diagnostic Criteria for the CT Angiography “Spot Sign” in Primary Intracerebral Hemorrhage**

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**PURPOSE**

The CT angiography (CTA) “spot sign” describes foci of intralesional enhancement associated with hematoma expansion in primary intracerebral hemorrhage patients. A consistent radiologic definition is required for two proposed recombinant Factor VIIa trials planning patient dichotomization according to “spot sign” presence or absence. We propose radiologic criteria for diagnosis of the CTA “spot sign” and describe different morphologic patterns.

**MATERIAL & METHODS**

Cases exhibiting the CTA “spot sign” were included for analysis from a prospective ICH cohort of 36 patients from the multicenter collaborative study. Three reviewers analyzed the CTA studies in a blinded protocol. Analysis of specific ICH and “spot sign” features was performed including prevalence, number, size, location, morphology and Hounsfield unit density.
RESULTS
Twelve of 36 patients (33%) demonstrated a total of 19 enhancing foci consistent with the CTA “spot sign”. Mean maximal axial “spot sign” dimension was 3.7 ± 2.2 mm and mean density was 216 ± 57.7 HU. No significant differences in age or blood pressure (p = 0.7), glucose (p = 0.9), INR/PTT (p = 0.3 and 0.4) or hematoma location (p = 0.3) were demonstrated between patients with or without the “spot sign”. Consensus definition criteria for the CTA “spot sign” are proposed and a classification of “spot sign” pattern is described.

CONCLUSION
The “spot sign” is defined as spot-like and/or serpiginous foci of enhancement, within the margin of a parenchymal hematoma without connection to outside vessels. The “spot sign” is greater than 1.5 mm in maximal dimension and has a Hounsfield unit density at least double that of background hematoma density.

KEY WORDS: Primary ICH, spot sign

Poster 136
CT Angiography Covering both Cervical and Cerebral Arteries Using a Reduced Dose and Higher Concentration of Contrast Material on a 16-Detector Row System

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PURPOSE
We assessed the feasibility of a CT angiography (CTA) protocol using a reduced dose (80 mL) and higher concentration (370 mgI/mL) of contrast on a 16-detector row system to visualize both cervical and cerebral arteries.

MATERIALS & METHODS
In 30 consecutive patients, we performed CTA covering cervical and cerebral arteries. The patients were assigned to one of three groups: group A: 100 mL of 300 mgI/mL; group B: 80 mL of 370 mgI/mL; and group C: 60 mL of 370 mgI/mL with a saline flush of 30mL. On source images, we measured the attenuation of the common carotid artery (CCA), internal jugular vein (IJV), proximal middle cerebral artery (MCA), basilar artery (BA), and straight sinus (SS). Additionally, two readers visually evaluated the degree to which the carotid bifurcation and arteries of the circle of Willis were demonstrated using a three-point grading scale on final images.

RESULTS
In all patients, CTA images well demonstrating both regions were obtained. There were no statistically significant differences in attenuation of the CCA, IJV, MCA, BA and SS among the three groups, the only exception being a lower attenuation of the MCA in group C than in groups A and B (p < 0.01). Neither were any significant differences noted among the three groups on the visual assessment.

CONCLUSION
CT angiography covering both cervical and cerebral arteries can be performed using contrast material of 80 mL of 370 mgI/mL on a 16-detector row system. Further dose reduction seems to be possible using a saline flush.

KEY WORDS: CT angiography, contrast agent

Poster 137
Perfusion-CT Imaging follows Clinical Severity in Left Hemispheric Strokes

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PURPOSE
The purpose of this study was to assess how imaging findings on admission perfusion CT (PCT) and follow-up non-contrast CT (NCT), and their changes over time, correlate with clinical scores of stroke severity measured on admission, at discharge and at 6-month follow up.

MATERIALS & METHODS
Fifty-two patients with suspected hemispheric acute ischemic stroke underwent a PCT within the first 24 hours of symptom onset and a follow-up NCT of the brain between 24 hours and 3 months after the initial stroke CT study. NIH Stroke Scale (NIHSS) scores were recorded for each patient at admission, discharge and 6 months; modified Rankin scores (mRS) were recorded at discharge and 6 months. Baseline PCT and follow-up NCT were analyzed qualitatively (volume of ischemic/infarcted tissue) and semiquantitatively (anatomical grading score derived from the Alberta Stroke Program Early CT Score). Correlation between imaging volumes/scores and clinical scores was assessed. Analysis was performed for all patients considered together and separately for patients with right and left hemispheric strokes.

RESULTS
Significant correlations were found between clinical scores and both quantitative and semiquantitative imaging. The volume of the acute PCT MTT lesion showed best correlation with admission NIHSS scores (R2 = 0.61 p < 0.001). This correlation was significantly better for left hemispheric strokes (R2 = 0.80, p < 0.001) than for right hemispheric strokes (R2 = 0.39, p = 0.131). Correlation between imaging and NIHSS scores was better than correlation between imaging and mRS scores (p = 0.047). Correlation with discharge clinical scores was better than the correlation with 6-month clinical scores (p = 0.012).

CONCLUSION
Baseline PCT and follow-up NCT volumes predict stroke severity at baseline, discharge, and to a lesser extent, 6 months. The correlation is stronger for left-sided infarctions. This finding supports the use of PCT as a surrogate stroke outcome measure.

KEY WORDS: Stroke, CT, clinical stroke severity
Residual Pituitary Adenomas after Surgical Treatment: Improved Depiction with Gadobenate Dimeglumine Compared to Gadopentetate Dimeglumine

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PURPOSE
Pituitary adenomas account for 10-15% of all intracranial primitive neoplastic lesions. Surgical debulking is often the first approach to management. However, residual adenomatous tissue after surgery can be detected in up to 50% of cases and is clearly associated with a high risk of tumor recurrence. Gamma knife surgery is frequently a good therapeutic option in these cases since the risk of damage to surrounding structures is minimal. In order to remove as much of the recurrent tumor as possible, accurate depiction of the residual tumor tissue is critical. Gadobenate dimeglumine (MultiHance; Bracco) has markedly greater r1 relaxivity in blood compared to traditional contrast agents because of weak and transient interaction with serum proteins. Numerous studies have shown that lesion enhancement and available diagnostic information is greater on gadobenate dimeglumine-enhanced images (1-3). However, little is known of the potential of gadobenate dimeglumine for improved depiction of residual pituitary adenoma. This preliminary study was performed to intraindividually compare gadobenate dimeglumine with gadopentetate dimeglumine at equivalent dose (0.1 mmol/kg bodyweight) for MR imaging of residual pituitary adenoma in patients who previously had undergone surgical treatment.

MATERIALS & METHODS
Institutional review board and regulatory approval were granted; written informed consent was obtained for all patients. Fifteen patients (6 males, 9 females) with residual pituitary adenoma amenable to gamma knife surgery were enrolled. Patients underwent two MR examinations at 1.5 T separated by 48 hours. The imaging parameters were identical for the two studies. Contrast agent administration was fully randomized: 10 received gadobenate dimeglumine for the first examination and gadopentetate dimeglumine for the second while the remaining five patients received the two agents in the reverse order. The first of the two examinations was performed after positioning the stereotaxic helmet. The volume and injection rate were identical for the two examinations. Images were evaluated in terms of lesion morphology, dimension and border delineation, degree and pattern of lesion enhancement, and definition of the involvement of nearby structures (e.g., cavernous sinuses). Overall preference for one examination over the other was assigned in blinded fashion in terms of lesion detectability and diagnostic confidence.

RESULTS
Gadobenate dimeglumine was considered superior to gadopentetate dimeglumine in 11/15 patients whereas gadopentetate dimeglumine was superior to gadobenate dimeglumine in just 3/15 patients. For the remaining patient the two agents were considered equivalent. Where a preference for gadobenate dimeglumine was expressed, the choice was due primarily to greater contrast enhancement and better lesion border definition both of which led to improved depiction of the residual pituitary adenoma.

CONCLUSION
Improved depiction of residual pituitary adenoma on follow-up MR imaging after surgical treatment is achievable with gadobenate dimeglumine compared to gadopentetate dimeglumine. The improved depiction of residual tumor may permit more accurate definition of the surgical target volume for subsequent gamma knife surgery.

REFERENCES

KEY WORDS: Pituitary adenoma, contrast enhancement, comparative studies

Evaluation of a Portable CT Scanner for Neuroradiology

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PURPOSE
To evaluate the technical and clinical performance of a portable CT scanner for neuroradiologic imaging.

MATERIALS & METHODS
Image quality performance of the CereTom portable head CT scanner were evaluated using an ACR CT accreditation phantom. Radiation dose measurements were obtained in a 16 cm diameter acrylic phantom (CTDI). Clinical results were evaluated in the first 22 patients including conventional noncontrast (28 studies), contrast (3 studies), angiography (2 studies) and perfusion (2 studies). Whenever possible, direct comparison was made with images acquired on standard clinical CT scanners within 48 hours, before or after the portable CT scanning.

RESULTS
Low contrast performance permitted the detection of 4 mm lesions at a contrast of 7 HU, and the limiting spatial resolution performance was 7 line pairs per mm. The measured CTDI Vol for a standard head CT scan was 58 mGy. All the acquired studies were of diagnostic quality, including perfusion CT, which provided 1 cm coverage. The visibility of hyperdense and hypodense lesions was good in all patients. Minor differences were noted on direct comparison with standard CT scans. The portable scanner images contained slightly higher levels of noise and artifacts, which was more prominent in the posterior fossa. Most of the portable studies also showed a slight reduction in contrast between the gray and white matter.
CONCLUSION
The portable CT scanner has good physical performance, and generates images that are satisfactory for routine clinical use.

KEY WORDS: Portable CT scanner, performance, radiation dose

Poster 140
A New and Failsafe Method of Labeling Cross-Sectional Images for Sidedness
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PURPOSE
To create a device that eliminates errors in labeling sidedness in cross-sectional imaging. If the technologist enters patient position parameters incorrectly, such as prone instead of supine, the computer will mislabel the images for sidedness. This does not happen often, but when it does it can be problematic for the patient and everyone else involved. A high percentage of wrong site surgeries are followed with medical malpractice lawsuits. This new device is to remove the human element so that human errors do not occur. The new device results in an “R” label in the image that cannot be manipulated by postprocessing.

MATERIALS & METHODS
A three-dimensional “R” marker is used to create a two-dimensional label of sidedness when the marker is imaged in cross section. The marker consists of a radiopaque circular rod with hollowed out central portion in the shape of the letter “R” that when imaged in cross section creates the “R” notation in the obtained image. The rod is attached to the right temple piece of a pair of eyeglass frames. The eyeglass frame has a tall bridge over the nose, so that the eyeglass frame can only be worn one way on a person. When the eyeglass frames are worn the rod will be adjacent only to the right side of the head or face. The device is similar in overall appearance to a diver wearing a facemask with snorkel attached on the right side. The rod rotates at its attachment point, so the the “R” symbol may be imaged in any plane from axial to coronal. Computed tomography images of the device on a phantom were obtained.

RESULTS
Cross-sectional images acquired with the device clearly show the “R” symbol on the right side of the anatomy within the image. The “R” is identified readily, as it is immediately adjacent to the anatomy. The device’s “R” mark is easier to notice that the smaller computer generated “R” and “L” at the margins of the image. The device’s “R” cannot be changed on the computer by the technologist after the fact as it is a part of the image, not an external annotation. If the images are flipped or otherwise electronically manipulated, the device’s “R” will still be adjacent to the right side of the anatomy. If a film is viewed backwards in the operating room, the device’s “R” mark is clearly visible adjacent to the anatomy, and the side of the pathology is readily apparent relative to the “R”.

CONCLUSION
This new method of labeling sidedness eliminates errors in labeling of cross-sectional images for sidedness and may lower the frequency of wrong site surgery.

KEY WORDS: Right, malpractice, error

Poster 141
Prevalence of Hippocampal Malrotation in the Seizure-Free Population
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PURPOSE
Hippocampal malrotation (HIMAL) is a failure of hippocampal inversion that occurs during normal fetal development. Hippocampal malrotation has been seen on MR examinations of patients with epilepsy (1). The purpose of our research is to evaluate the prevalence of HIMAL in MR examinations performed on patients without seizures in order to understand the significance of HIMAL in the seizure population.

MATERIALS & METHODS
Five hundred five MR examinations with thin-section imaging through the temporal lobes of patients without seizures were reviewed. The examinations were performed on 1.5 T or 3.0 T magnets. Sagittal T1-weighted and coronal T2-weighted or FLAIR images were used to evaluate each MR for the distinctive features of HIMAL. The criteria for HIMAL are: incomplete rotation of the hippocampus with an abnormally rounded shape, one-sided involvement of the entire hippocampus, normal signal intensity and size of the hippocampus with a hazy inner structure, atypical collateral sulcus angle, atypical position and size of the fornix, normal temporal lobe size, enlarged temporal horn resembling its appearance in conditions of corpus callosum agenesis, and a normal corpus callosum (1).

RESULTS
None of the patients’ MR examinations fulfilled all the criteria for HIMAL. Seven MRs satisfied two or more criteria. Two hundred ninety-one patients had a low position of one fornix.

CONCLUSION
Hippocampal malrotation is a rare finding in patients without seizures. An incidental finding of HIMAL should therefore arouse suspicion of an underlying developmental disorder or seizure disorder.
REFERENCES

KEY WORDS: Hippocampus, development, epilepsy

Poster 142
High-Resolution 7 T MR Imaging of the Human Hippocampus In Vivo

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PURPOSE
Very high field clinical MR scanners are now available for advanced neuroimaging. This work describes initial experience imaging the human hippocampus in vivo using a 7 T MR scanner and a protocol developed for very high field clinical neuroimaging.

MATERIALS & METHODS
Six normal subjects were scanned on a 7 T Achieva whole body MR scanner (Philips Medical Systems, Cleveland, OH, USA) equipped with a 16-channel head coil (Nova Medical Inc., Wilmington, MA, USA) using a subset from a previously described clinical neuroimaging protocol optimized for 7 T imaging (1). One of these subjects also was scanned at 3 T using a similarly optimized protocol for comparison. 7 T sequences included high spatial resolution full field of view T1-weighted 3D turbo field echo (3D TFE: TR/TE = 5.5/2.6 ms; nominal FA = 7°; FOV = 246.4 x 246.4 x 173.6 mm, Matrix = 352 x 352 x 248, SENSE factor = 2.9 for 700 µm isotropic voxels; Imaging time = 08:58), T2*-weighted 2D fast field echo (2D FFE: TR/TE = 434/11.8 ms; nominal µm isotropic voxels; Imaging time = 08:58), T2*-weighted 2D fast field echo (2D FFE: TR/TE = 434/11.8 ms; nominal FA = 40°; Slices = 24; slice thickness = 2.5 mm; FOV = 240 x 180 x 150 mm, Matrix = 480 x 480, SENSE factor = 2.0, for 500 µm in plane resolution; Imaging time = 05:20). Total imaging protocol duration, including SmartScout and SENSE reference scan was approximately 23 minutes.

RESULTS
High-resolution images collected at 7 T provided superior conspicuity of hippocampal structures in clinically practical imaging times. Three-dimensional TFE images provided excellent anatomical depiction of macroscopic hippocampal structures, including the alveus, Cornu Ammonis and dentate gyrus. T2* weighted 2D FFE images with 0.5 mm in-plane resolution and 2.5 mm slice thickness provided clear discrimination of the Cornu Ammonis and the compilation of adjacent less cellular sublayers of the hippocampus. SWI images (0.5 mm in-plane resolution, 1.0 mm slice thickness) identified fine microvenous anatomy of the hippocampus.

CONCLUSION
When compared with a 3 T protocol used routinely for clinical assessment of hippocampal structure in seizure patients at our institution, this 7 T protocol of similar total duration (23 min) provided superior conspicuity of hippocampal anatomy, particularly the hippocampal head and body, and associated venous structures. This increased conspicuity is likely to provide greater diagnostic sensitivity for hippocampal pathology.

REFERENCES

KEY WORDS: High field MRI, anatomy, hippocampus

Poster 143
Paratracheal Air Cysts: A Common Finding on Routine CT Examinations of the Cervical Spine and Neck which May Mimic Pneumomediastinum in the Trauma Patient

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PURPOSE
This study is designed to demonstrate the appearance, clinical presentation, and prevalence of paratracheal air cysts, which, on CT examinations of the neck, can mimic abnormal extraluminal air.

MATERIALS & METHODS
Seven hundred two consecutive CT examinations of the cervical spine or soft tissue of the neck were reviewed. All examinations were at 2 - 5 mm thickness. Sagittal and coronal reconstructions available for review if necessary. Paratracheal air cysts were evaluated for size, the presence of visible communication with the trachea, association with pneumothorax, pneumomediastinum or subcutaneous emphysema, and association with findings of emphysematous changes in the lung apices. The patient demographics of age, sex, and whether the patient had been in a trauma also were collected.

RESULTS
A total of 26 (3.7%) patients out of the 702 patients evaluated had paratracheal air cysts, all of which were found on the right, at the level of the thoracic inlet from C6-T1. Ages ranged from 15-74 years. In nine (34.6%) of these a direct communication with the trachea was seen. Three-dimensional TFE images of the cervical spine and neck which may mimic pneumomediastinum in the trauma patient.

KEY WORDS: High field MRI, anatomy, hippocampus
CONCLUSION
Right paratracheal air cysts are a common CT finding which occur in a predictable location. In the setting of trauma, these characteristic structures can mimic pneumomediastinum, and are seen in 3-4% of the study population. The etiology is unclear, but may be either congenital, or may be an acquired phenomenon, given that they often are seen in both children and adults. We found no association with either trauma or presence of emphysematous changes in the lung apices.

KEY WORDS: Tracheal, diverticulum, cervical spine

Poster 144
Age, Sex and Body Mass Index Evaluation in Relation to Cranial Diploe Thickness and Anthropometric Data on MR Imaging
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PURPOSE
It might be critical to determine the sex, body vault and age of the individual from the skull in forensic medicine and anthropology. Our purpose in this study was to evaluate whether a relationship existed between the diploeic bone thickness measured from glabella, bregma, lambda, opisthocranion, euryon regions and the sex, age and body mass index of the individual. Glabella-opisthocranion, vertex-basion, euryon-euryon length also were determined for the same purpose. Earlier studies were on calvarial total (external table-diploe-internal table) thickness and length of some specific craniometric landmarks.

MATERIALS & METHODS
The measurements were obtained in 50 individuals (26 male, 24 female) who underwent cranial MRI studies in our institution. The mean age was 40.38 ± 17.28 years. The mean craniometric points were determined on sagittal and axial T1-weighted sequences and measurements were obtained on a workstation by two radiologists.

RESULTS
There was a statistically significant difference in diploeic thickness in the glabella region and in the vertex-basion, euryon-euryon length between males and females. There was a statistically significant relationship among age of the individual and glabella, lambda, opisthocranion and left euryon region diploeic thickness. There was a statistically significant relationship among body mass index and euryon-euryon length and diploeic thickness in the lambda region.

CONCLUSION
A standard cerebral MRI examination would be sufficient to obtain anthropometric data. According to this preliminary study, it might be possible to identify the age, sex and body mass index of the individual by determining the diploeic thickness and length of some specific craniometric landmarks.

KEY WORDS: Diploe, MRI, body mass index

Poster 145
Head and Neck Squamous Cell Carcinoma: Correlation of Apparent Diffusion Coefficient with Degree of Cytologic Differentiation
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PURPOSE
To retrospectively evaluate whether the apparent diffusion coefficient (ADC) correlates with degree of cytologic differentiation of head and neck squamous cell carcinoma (HNSCC).

MATERIALS & METHODS
Findings from 22 patients (14 men, 8 women; mean age, 57 ± 13.9 years) with pathologically proved HNSCC were evaluated retrospectively. The primary sites of HNSCC included palatine tonsil (n = 9), tongue (n = 9), buccal space (n = 2), gingiva (n = 1), and lip (n = 1). Single-shot spin-echo echo-planar diffusion-weighted imaging was performed with b-factor of 0 and 1000s/mm² in axial direction. Using MatLab-based in-house software, mean ADC of each tumor calculated from multiple circular regions of interest placed on solid component of the tumor. Correlation analysis was performed between the mean ADC and the degree of cytologic differentiation of HNSCC using Spearman correlation coefficient.

RESULTS
There were 10 patients with well differentiated, seven with moderately differentiated and five poorly differentiated HNSCC. The mean ADC of HNSCC was (1.12 ± 0.43) x 10⁻³ mm²/sec. The mean ADCs of each cytologic group were (1.47 ± 0.46) x 10⁻³ mm²/sec in well differentiated HNSCC, (1.05 ± 0.26) x 10⁻³ mm²/sec in moderately differentiated...
HNSCC, and \((0.88 \pm 0.13) \times 10^4 \text{ mm}^2/\text{sec}\) in poorly differentiated HNSCC. There was a significant negative correlation between the mean ADC and the degree of cytologic differentiation \((r = -0.77, p < 0.0001)\).

**Conclusion**
The mean ADC of HNSCCs can provide additional information about their degree of cytologic differentiation.

**Key Words:** Squamous cell carcinoma, DWI, head and neck

**Poster 146**
**Evaluation of Residual/Recurrent Squamous Cell Carcinoma of the Oral Cavity and Oropharynx with [18F] Fluorodeoxyglucose Positron-Emission Tomographic CT**

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**Purpose**
The study goal is to assess the clinical utility of [18F] fluorodeoxyglucose positron emission tomographic CT (PET-CT) in the assessment of recurrent or residual disease in previously treated patients with oral cavity and oropharyngeal squamous cell carcinoma.

**Materials & Methods**
We retrospectively reviewed records of patients referred for PET/CT scanning over an 8-month period with clinical suspicion of residual or recurrent squamous cell carcinoma of the oral cavity and oropharynx based on the onset of new symptoms and/or new clinical findings. We included in the study 18 subjects (average age 60.9 +/- 12.2, 12 males) for which pathology correlations (12 cases) or clinical follow up of at least 12 months (six cases) were available. PET/CT images were interpreted with knowledge of the clinical history. The presence or absence of imaging findings consistent with residual or recurrent tumor at the primary site was recorded for each case. Two radiologists interpreted the imaging findings and discrepancies were resolved by consensus.

**Results**
At the primary site the sensitivity, specificity and accuracy of [18F] PET-CT for the presence of residual/recurrent disease were respectively 100%, 62.5% and 83.3%. Three cases of suspected recurrent base of tongue squamous cell carcinoma proved to be false-positive based on absence of tumor on multiple biopsy specimens. In two of these three cases the pathology specimen revealed dysplasia and squamous atypia of the soft palate and base of tongue. Average maximal standardized uptake values measured at the site of suspected oral cavity/oropharyngeal residual or recurrent tumor were not significantly different between false positive (FP, three cases) and true positive (TP, 10 cases) cases \((FP = 6.8 +/- 2.9; TP = 6.7 +/- 3.5; Z = 0.462, p = 0.644)\). In five cases, no findings suspicious for recurrence at the primary site were seen on [18F] PET-CT. In one of these cases multiple biopsies were performed, which confirmed the absence of residual or recurrent tumor; in the remaining four cases clinical follow up showed absence of disease for at least 12 months.

**Conclusion**
In conclusion our data suggest that [18F] PET-CT is a promising imaging modality in the early detection of residual/recurrent head and neck carcinoma of the oral cavity and oropharynx, and offers the potential to accurately guide biopsy. In cases where suspicious findings are absent on [18F] PET-CT and clinical examination, further unnecessary diagnostic and surgical procedures can be safely avoided.

**Key Words:** Head and neck malignancies, 18F FDG positron-emission tomography CT

**Poster 147**
**Is Thyroglobulin Level a Useful Predictor of PET Demonstration of Recurrent or Metastatic Thyroid Carcinoma?**

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**Purpose**
Thyroglobulin (Tg) levels have a well established role in the follow up of patients with papillary thyroid cancer (PTC). Historically, patients who develop or have persistently elevated levels of Tg were evaluated for PTC recurrence or metastases with I-131 whole-body scans and other radiographic imaging. More recently, FDG-PET has been used increasingly as it has been shown that some types PTC lose their ability to concentrate I-131, thus are negative on I-131 whole body scans but positive on PET. This study evaluates the correlation between Tg levels and PET positivity. In particular, there is a Tg level below which PET is consistently negative, thus negating the need for PET in patients with Tg levels below this threshold.

**Materials & Methods**
Records and images of 44 patients with PTC who had PET and well documented thyroglobulin levels from January 1, 2006 - July 31, 2007 were studied. Patients were eligible for PET scanning if they had elevated thyroglobulin levels (above 1.0 ug/L at our institution) with negative iodine-131 scan and negative findings with other radiologic imaging. Thyroglobulin levels were correlated with PET findings.

**Results**
Recurrent or metastatic disease was discovered by PET in 12 of the 44 patients. The thyroglobulin levels in the PET positive patients ranged from 1.0-156.0 ug/L while in the PET negative patients the range was 1.0-586.0 ug/L (Fig 1). The mean Tg level in PET positive patients was 18.7 ug/L (SD of 42.6 ug/L) and in PET negative patients was 28.9 ug/L (SD of 109.7 ug/L). There were 25 patients that had time to be followed appropriately with either pathology or imaging. These follow-up studies have shown that there are three false positive PETs and four false negatives. In particular there was one PET negative thyroglobulin level of 586.0 ug/L that was a false negative PET.
Conclusions

The degree of thyroglobulin elevation does not predict which patients will demonstrate recurrence with PET scanning and should not be used as a discriminating factor to determine which patients should receive PET. In addition, preliminary results from our registry show that the sensitivity and specificity of PET itself is questionable. Further analysis of our registry patients, as their follow-ups continue, need to be evaluated to ultimately determine what the true role of PET should be in patients with PTC.

Key Words: PET, thyroid

Poster 148

Image Quality of Neck CT and CT Angiography with Bismuth Thyroid Shielding

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Purpose

The purpose of our study is to determine that reduction of radiation dose to the thyroid gland can be achieved without compromise of diagnostic image quality, using Bismuth shielding.

Materials & Methods

Eighteen examinations of neck CT and neck CTA were performed using a Bismuth shield placed over the thyroid gland. Subjective image quality assessment and quantification of noise level of these examinations were compared with 18 subjects who underwent neck CT/CTA without Bismuth shielding (a control group). All studies were performed with a 16-slice MDCT. The shield was placed after scout images were obtained and remained in place for the duration of the study. Each study was evaluated by a board-certified radiologist for overall image diagnostic quality and image quality in three anatomical areas: thyroid, cervical spine and cervical vasculature. A five-point grading system was used for evaluation. The noise was measured using four, selected regions if interest (ROIs) in the anterior neck. A phantom, with and without Bismuth shielding was imaged for quantification of radiation dose using thermoluminescent dosimeters.

Results

All shielded studies were considered diagnostic by a board-certified radiologist. Streak artifact from the shield was present on all but two studies. In the affected studies, the thyroid and cervical vascular demonstrated an average reader rating of little streak artifact, no effect on image quality. The cervical spine showed an average reader rating of no streak artifact. The objective noise levels were 16.5 and 15.4, for shielded and nonshielded studies, respectively. The difference was not statistically significant, p = 0.3207. The phantom study showed approximately a 50% reduction of radiation dose.

Conclusion

The radiation dose to the thyroid gland during CT and CTA neck examinations is significantly reduced with Bismuth shielding. There is no loss of overall diagnostic quality or increased noise level. The ease of use and availability of the shields can facilitate radiation protection, as application of CT is becoming increasingly widespread. This potentially may alter the future incidence of thyroid carcinoma secondary to iatrogenic radiation exposure.

Key Words: Thyroid, bismuth, shield

Poster 149

MR Imaging of Acute Optic Neuritis: Optic and Perioptic Conditions

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Purpose

The second cranial nerve or the optic nerve and the perioptic subarachnoid space (SAS) are surrounded by a sheath, and the cerebrospinal fluid space forms a “cul de sac” at the cribiform plate. The smallest diameter of the SAS of the optic nerve is within the optic canal. Pathologically, there are two categories of optic neuritis according to the affected sites: optic neuritis in a narrow sense which affects the optic nerve itself and optic perineuritis which affects the perioptic SAS and sheath. There is also a pathologic condition called optic neuropathy. The purpose of this study was to evaluate MR findings in patients who presented with visual impairment and were clinically diagnosed as acute optic neuritis.

Materials & Methods

MR imaging was performed in 20 patients who presented with acute visual impairment or misty vision and were suspected of having optic neuritis. Nine of these patients had multiple sclerosis (MS). Of the remaining 11 patients without MS, two had optic neuritis associated with meningitis or cerebritis, one had Behcet’s disease, one had Wegener’s granulomatosis and seven had idiopathic optic neuritis. General Electric 1.5 T Signa scanner was used. The optic nerve was divided into three segments: intracranial, optic canal, and orbital segments for evaluation. For each segment, using gadolinium (Gd)-enhanced T1-weighted and fat-suppressed T2-weighted images, the Gd enhancement, increase in T2 relaxation time and swelling of the optic nerve
and the enlargement of the perioptic CSF space were evaluated retrospectively with blindness of clinical diagnosis. In some patients, diffusion-weighted images (DWI) also were obtained around the same period and the increase in signal intensity of the optic nerve was assessed.

**RESULTS**
Optic neuritis associated with MS was found in seven of nine MS patients. In these patients, the increase in T2, swelling and Gd enhancement of the optic nerve were localized; the localized signal change was found in the area from the intracranial segment to the more proximal part of the optic canal segment. One of the patients under follow up for idiopathic optic neuritis had the above-mentioned signal change and swelling localized to the optic nerve. However, in the majority of patients with idiopathic optic neuritis the increase in T2 and Gd enhancement of the perioptic area tended to be more marked than those of the optic nerve. In case with Wegener’s granulomatosis, granular enhancement was seen around the optic nerve. In patients with meningitis, enhancement was observed along the perioptic SAS in addition to enhancement effect in the cranial meninges. Diffusion-weighted images of some patients showed increased signal intensity in the optic nerve.

**CONCLUSION**
MR imaging demonstrates the various pathologic conditions of acute optic neuritis and optic perineuritis. Optic perineuritis is distinct from demyelinating optic neuritis on MR imaging. Idiopathic optic neuritis is thought to have a broad spectrum including optic and/or perioptic disorders. MR imaging is expected to be useful in predicting the outcome of the acute optic neuritis.

**KEY WORDS:** Optic neuritis, MR imaging, optic nerve subarachnoid space

**Poster 150**

**Metastatic Gynecologic Malignancy within the Head and Neck**

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**PURPOSE**
The purpose of this study was to assess the imaging features of neck lymphadenopathy secondary to gynecologic malignancy.

**MATERIALS & METHODS**
A retrospective study was performed at a University-affiliated cancer center. The local radiology information system (RIS) was queried to select for cases with dedicated CT head and neck examinations requested by attending gynecologic oncologists, from January 1, 2000 to October 31, 2007. The electronic medical record of each case was reviewed for information regarding the inclusion and exclusion criteria, as well as demographic information, age at the time of scan, date of death, disease stage, tumor histology, and any available pathologic correlation for neck lymphadenopathy.

**RESULTS**
Of the 35 cases obtained, five were excluded because of the presence of an additional nongynecologic malignancy. The average age at the time of scan was 54.2 years +/- 13.0 years. In total, 80% (24/30) of patients had head and neck lymphadenopathy while 20% (6/30), did not. Of the 24 cases with lymphadenopathy, 21% (5/24) were bilateral and 79% (19/24) were unilateral. Supraclavicular lymphadenopathy was the most common, being present in 75% (18/24) of patients, left greater than right. One-third of the cases did not have Virchow nodal disease (left supraclavicular), one-third had only a Virchow node and one-third had both Virchow nodal and additional lymph node level metastatic disease.

**CONCLUSION**
Head and neck metastatic lymphadenopathy can arise in a significant percentage of patients with gynecologic malignancy. Nodal disease can arise in nodes other than the classic Virchow’s node. If a patient presents with just a palpable Virchow lymph node in the setting of gynecologic tumor, the whole neck needs to be imaged for complete evaluation.

**KEY WORDS:** Gynecologic, lymphadenopathy, neck

**Poster 151**

**Preliminary Anatomical Results of Clarity Study and Evaluation of a New Classification for Evaluation of Angiographic Results after Aneurysm Embolization**

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**PURPOSE**
Clarity Study is a French multicenter, prospective, consecutive and controlled study of the embolization considered as the first intention treatment of ruptured aneurysms. Our goal is to present the preliminary angiographic results according to J. Raymond Classification (JRC) and to evaluate the use of a new classification.

**MATERIALS & METHODS**
Four hundred eight patients were treated consecutively of a ruptured intracranial aneurysm. The aneurysm was located at the anterior circulation in 90.9% and posterior circulation in 9.1% of the cases. Embolization procedure was successful in 97.5% of the cases. It was performed with coils alone in 79%, with balloon remodeling technique in 20.4% and with stent in 0.5% of the cases. The angiographic results were analyzed initially by the operator then assessed by a core Lab of two independent reviewers with a separate analysis then a consensus. Results were classified according to JRC. A new classification was evaluated: A) Complete aneurysm occlusion (complete neck coverage and no contrast within coils); B) Subtotal occlusion with B1 (complete neck coverage but
contrast within coils), B2 (not complete neck coverage but no contrast within coils), B (not complete neck coverage and contrast within coils); C) Incomplete occlusion.

RESULTS
Initial posttreatment angiographic results according to JRC obtained by a consensus of the two reviewers were: Complete occlusion: 150 cases (48.0%); Neck remnant: 120 cases (38.5%); Residual aneurysm: 42 cases (13.5%). In the new classification results were: A: 119 cases (38.1%); B1: 44 cases (14.1%); B2: 64 cases (20.5%); B3: 45 cases (14.4%); C: 40 cases (12.8%). In the two classifications interobservers reliability was good. Aneurysms classified as complete occlusion JRC were: A in 119 cases (79.3%); B1 in 30 cases (20.0%) and B2 in one case (0.7%). Aneurysms classified neck remnant JRC were: B1 in 14 cases (11.6%), B2 in 63 cases (52.5%); B3 in 43 cases (35.8%). Those residual aneurysms JRC were B3 in two cases (4.8%) and C in 40 cases (95.2%).

CONCLUSION
Clarity Study (multicenter, prospective, consecutive study of embolization when considered as the first intention treatment of ruptured aneurysms) confirms the need of independent evaluation of angiographic results. We propose a new classification in an attempt to more precisely describe angiographic results after embolization and specifically in cases with poor neck coverage or persistent contrast filling of coils mesh. Its efficacy and interest need to be proved in long-term follow-up evaluation.

KEY WORDS: Embolization, aneurysms, angiographic results

Poster 152
TEAM: A Trial on Endovascular Aneurysm Management
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PURPOSE
The management of patients with unruptured aneurysms is controversial. Patients with unruptured aneurysms may suffer intracranial hemorrhage, but the incidence of this event is still debated. Endovascular treatment can prevent rupture, but involves immediate risks; furthermore, successful treatment does not eliminate all risks. Safety and efficacy of endovascular treatment of unruptured aneurysms remain underdetermined; hence, the balance of risks and benefits is uncertain. A randomized trial may be the best way to demonstrate the potential benefits of endovascular management of unruptured aneurysms. The primary objective is to compare the combined mortality and morbidity (modified Rankin Score ≥ 3) from intracranial hemorrhage in those treated by endovascular coiling and those treated by conservative management (i.e., deferral for 10 years or until definite indications are thought to have arisen). Secondary objectives evaluate the incidence of hemorrhagic events in both groups, the morbidity related to endovascular coiling, morphologic results at 5 and 10 years, overall clinical outcome at 5 and 10 years, and cognitive and quality of life status.

MATERIALS & METHODS
This is a randomized, multicentre, controlled trial conducted in 60 international centers. The duration of the study is 14 years, with 3 years for patient recruitment and a minimum of 10 years of follow up. Trial participants are candidates for endovascular treatment of one or more unruptured intracranial aneurysms (size 3-25 mm); unruptured aneurysms may be discovered recently or prevalent. The entire study will enrol 2,002 patients equally divided between the endovascular treatment group and the observation group, a size sufficient to achieve 80% power at a 0.0167 significance level to detect differences in disease versus treatment-related poor outcome from 7-9% to 3-5% and overall mortality from 16 to 11%. Outcome measures and analysis. The analyses will be performed on two populations: intent-to-treat and per protocol. The main statistical tests will involve comparisons between both groups of the 5/10 years probabilities of: 1) poor outcomes from hemorrhage related to the lesion, excluding per-operative complications; 2) mortality from hemorrhage or from complications of treatment; 3) combined disease or treatment related mortality and morbidity in the absence of other causes of death or disability. A committee, unaware of group assignment, will adjudicate the relation to disease or treatment. Other analyses will involve Kaplan-Meier life-table methods to assess the 5- and 10-year mortality from intracranial bleeding or from treatment among all those allocated immediate coiling and all those allocated deferral of any intervention as well as overall mortality.

RESULTS
Recruitment was initiated in June 2006 and will proceed until 2010 in North America, Europe and Asia; follow up is until 2020. The number of centers enrolled and active, and the number of patients recruited until now indicate that such a trial is feasible.

CONCLUSION
There is still no scientific evidence to support the treatment of unruptured aneurysms. The TEAM trial shows that a randomized controlled trial is possible despite the discomfort regarding randomization with respect to the management of unruptured aneurysms.

KEY WORDS: Unruptured aneurysm, endovascular, conservative management

Poster 153
Follow-up Angiography of Coil Embolizations for Intracranial Aneurysms: Comparison between Stent-Assisted and Unassisted Embolizations
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PURPOSE
Stents act as a mechanical barrier for containment of coils during embolization of wide neck aneurysms. The consequences of these stents on the long-term outcome of the embolized aneurysm are not well known. The purpose of this
study is to assess and compare the DSA follow-up results of stent-assisted (StA) and unassisted (UnA) coil embolization of intracranial aneurysms.

**MATERIALS & METHODS**

From a database of 637 aneurysms treated by coil embolization, patients with follow-up DSA (> 1 month postembolization) were selected including 24 StA (M:F = 4:20, mean 58.1 years old) and 99 UnA cases (M:F = 31:68, mean 52.9 years old). The aneurysms were classified by size [small (< 10 mm) or large (≥ 10 mm)], location (sidewall, bifurcation, or terminal bifurcation), and neck (wide defined as neck diameter ≥ 4 mm or dome/neck ratio < 1.5). The angiographic outcome of the embolization was classified as complete, near complete, incomplete, partial, and failure. Complete and near complete occlusions were regarded as treatment follow-up (FU) success. Findings on FU DSA were classified as stable, thrombosis, compaction, and regrowth. Any compaction or regrowth were considered as FU recanalization. Major recurrence was defined as substantial recanalization requiring retreatment. The volumetric measurements were calculated using the cerebral aneurysm calculator. The clinical and aneurysm characteristics, treatment success, and FU DSA findings for StA group and UnA group were assessed and compared.

**RESULTS**

The mean duration of follow up was 14.6 (StA) and 19.5 (UnA) months, respectively. The StA group consisted of less ruptured (25% vs 49.5%, p < 0.05) but more wide neck aneurysms (100% vs 42.2%; p < 0.05). No cases showed significant in-stent stenosis in the StA group on FU DSA except for one case which showed total occlusion of the parent artery after discontinuation of the antiplatelet medication due to subdural hematoma. One case presented with rehemorrhage 34 months after UnA embolization of a basilar tip aneurysm. The initial treatment success rates were 79.2% and 82.8% with coil packing volume of 24.7% and 26.6%, respectively. The overall FU treatment success rates for the StA and UnA aneurysms were 70.8% and 71.7%. FU recanalization (20.8% vs 31.3%) and major recurrence rates (12.5% vs 18.2%) did not differ significantly but progressive intrasaccular thrombosis was more frequent in StA group (50% vs 26.2%; p < 0.05). For small aneurysms, the FU recanalization rates (0% vs 25%; p < 0.05) were lower with higher progressive intrasaccular thrombosis (62.5% vs 27.6%; p < 0.05) rates in the StA group. Comparison of the wide neck aneurysms showed lower rate of FU recanalization in the StA small aneurysm group (0% vs 25%; p < 0.05). There was no significant difference in the FU results between the location types of the aneurysms.

**CONCLUSION**

Coil embolization is an effective treatment method for intracranial aneurysms; however, changes on follow up may affect the long-term outcome. Stent assistance may aid in preserving and enhancing the treatment durability especially in small aneurysms.

**KEY WORDS**: Aneurysm, coil, stent
CONCLUSION
Diagnosis of cortical dissection is difficult and its frequency is probably under estimated. Parent vessel occlusion in the acute phase is the first therapeutic option and, when performed, is usually well tolerated. When not possible or too risky, especially in case of MCA dissections, early angiographic follow up is mandatory and according to its results delayed treatment has to be discussed.

KEY WORDS: Dissecting aneurysms, intracranial hemorrhage, endovascular treatment

Poster 155
Innovative Method to Construct Silicone Cerebral Aneurysm Replicas

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PURPOSE
The aim of this study is to develop an efficient build process to fabricate silicone cerebral aneurysm replicas with good optical clarity, uniform wall thickness and proper mechanical properties for testing new endovascular devices.

MATERIALS & METHODS
Imaging modalities such as CTA, MRA and 3DRA were used to acquire the 3D morphology of cerebral aneurysms. Two postprocessing software, Mimics and Magics, translated the image data to a computer-aided design model. A mold with a core-shell structure was created for silicone injection, and the space between the core and shell represented the wall thickness of the silicone replica, which can be controlled precisely and easily. The virtual computer design was sent to fabricate silicone cerebral aneurysm replicas with good optical clarity, uniform wall thickness and proper mechanical properties for testing new endovascular devices.

RESULTS
The silicone replicas made from Sylgard 184 and LIM 6030 were both optically transparent. The stress-stretch curve (S-S curve) of Sylgard 184, LIM 6030, and human cerebral all presented a nonlinear relationship. The stretch increased with a little increase in stress, resulting in a lower modulus at low strains with a similar modulus of elasticity between the models and the ex vivo data. The stress required to extend the sample increased dramatically at the second stage. This phenomenon was not seen clearly on LIM 6030, because the LIM 6030 strips were still under stretched while the test was stopped. The specification and structure distinction of the MCA and silicone rubber specimens may contribute to the notable difference in the modulus. During the manufacturing process, the model needs to be rinsed with xylene to smooth the inner wall. It was found that repeating rinse procedure at a 5-second interval for 1 min achieved a good smoothing result. The rinsed mold needs to be dried in the ventilation system before silicone infusion. Silicone needs to be injected slowly into the mold from bottom to top. This can effectively avoid the bubble generation.

CONCLUSION
By using this method, the transparent, true-to-scale silicone models with different wall thickness and shape have been constructed successfully and applied for different medical applications.

REFERENCES

KEY WORDS: Aneurysm, vascular replica, in vitro model

Poster 156
Phosphorylation of Akt Protein Elevated in Elastase-Induced Saccular Aneurysms with High Height-to-Neck Aspect Ratio

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PURPOSE
Phosphorylation reactions have been implicated in the regulation of many biochemical and molecular events in different stages of cellular proliferation and differentiation. The purpose of the present study was to explore morphology-specific features of saccular aneurysms and predict specific hemodynamic settings that can be correlated to degree of phosphorylation of a specific protein, Akt, which plays a vital role in controlling survival and apoptosis.

MATERIALS & METHODS
Elastase-induced saccular aneurysms with high and low aspect ratio (height-topneck width) were created in 12 rabbits (n = 6 for each group). Three-dimensional rotational angiography (3DRA) was performed at the end of the experimental period (12 weeks after aneurysm creation) and used to construct 3D computational models of the vasculature. Numerical simulations of blood flow in the 3D models were performed using a commercial CFD solver with the assumption of Newtonian fluid properties for blood and rigid wall properties for the aneurysm and surrounding arteries. Steady flow analysis with flow rates based on case-specific average flow rates measured with an ultrasound system utilizing pulsed-wave spectral Doppler on a linear array transducer were performed in representative low aspect ratio (1.27) and high aspect ratio (2.8) geometries. Expression of Akt protein and the level of phosphorylated Akt protein were analyzed by Western blotting in different parts of the aneurysms...
[upper sac (dome), proximal lower half and distal lower half] and in control arteries (unoperated, contralateral carotid arteries).

### RESULTS

In the low aspect ratio model, a single vortex was observed in the aneurysm and the wall shear stress (WSS) was greater than 0.4 Pa throughout the majority of the sac. In the high aspect ratio model, a second vortex was found in the dome of the aneurysm and the WSS was largely less than 0.1 Pa. The WSS was enhanced in the lower half of the sac, but remained less than 0.4 Pa in most regions. The concentration of Akt protein was not different among the low and high aspect ratio aneurysms and control tissue. The concentration of phosphorlated Akt was statistically significantly higher in the domes of high aspect ratio aneurysms as compared to lower sac of high aspect ratio aneurysms, low aspect ratio aneurysms and control tissue.

### CONCLUSION

The regions of increased concentration of phosphorylated Akt correlated with locations of WSS less than 0.1 Pa. Elevated level of protein phosphorylation in the rabbit elastase model was found to correlate with aneurysm morphology. The model may be of value in studying biological processes in saccular aneurysms.

### KEY WORDS: Aneurysm, phosphorylation, computational flow dynamics

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**Poster 157**

**Comparison of Hemodynamics of Intracranial Aneurysms between MR Hemodynamic Analysis and MR-Based Computational Fluid Dynamics**

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**PURPOSE**

Vascular model and boundary conditions are very important factors affecting the accuracy of computational fluid dynamics (CFD) for intracranial aneurysms. The purpose of our study was to compare three dimensional (3D) streamlines and wall shear stress (WSS) of the aneurysm of MR hemodynamic analysis and MR-based CFD.

**MATERIALS & METHODS**

Three-dimensional cine PC MR imaging was performed for an internal carotid posterior communicating (ICPC) artery aneurysm (diameter, 3 mm) and a basilar tip aneurysm (diameter, 6 mm) by 1.5 T GE MR scanner. 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, 1x1x0.8 mm; VENC, 60 cm/s; each imaging time, 10 to 15 min; transaxial direction; gated with ECG, 20 phases. Three-dimensional TOF MR angiography was performed for geometric information. Our in-house software calculated 3D streamlines and WSS. The blood flow in the aneurysms was modeled using CFD simulation. The unsteady, incompressible Navier-Stokes equations were solved using a commercial package, based on the finite element method. The lumen surface was the same for both MR hemodynamic analysis and CFD. Temporal flow vectors for each point on the inlet surface, which were linearly interpolated based on the 3D cine PC MR imaging data set, were used as boundary conditions for CFD. The pressure of the outlet surface was assumed to be zero. The vessel was modeled as rigid and the nonslip velocity condition was specified at the wall. Three-dimensional streamlines and WSS distribution maps were obtained by CFD. We compared 3D streamlines and wall shear stress of the aneurysm between MR hemodynamic analysis and MR-based CFD. We also analyzed time-resolved flow volume of the proximal part and the distal parts of the parent arteries of the aneurysms.

**RESULTS**

The pattern of the 3D streamlines and distribution of WSS of the ICPC artery aneurysm were similar between MR hemodynamic analysis and MR-based CFD. However, MR-based CFD of the larger aneurysm showed 3D streamlines starting to rotate closer to the neck of the aneurysm than MR hemodynamic analysis. The location of the top of the spiral flow and the distribution of WSS of the basilar tip aneurysm were different for each method. The flow measurement of the inlet and outlet surface of CFD domain using 3D cine PC MR imaging data set demonstrated that their peak time was the same for the 3 mm aneurysm but that the peak volume of the outlet surface was 92 msec later than that of inlet surface for the 6 mm aneurysm. Larger aneurysms may significantly change their volume during cardiac cycle, so CFD using rigid vascular model might not be able to simulate hemodynamics of the aneurysm with increased volume during the systolic phase.

**CONCLUSION**

Our data demonstrated many differences in streamlines and WSS between MR hemodynamic analysis and MR-based CFD for the larger aneurysm. One reason was thought to be that the vascular model used in this CFD analysis was rigid and therefore not accurate.

### KEY WORDS: Intracranial aneurysms, MRI, computational fluid dynamics

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**Poster 158**

**Experimental Evaluation of Closed-Cell, Resheathable Intracranial Stents for the Removal of Foreign Bodies and Clot**

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**PURPOSE**

To experimentally evaluate the technique of employing a closed-cell, resheathable neurovascular stent for the removal of foreign bodies or clot from the cerebrovascular system.
Materials & Methods
In vitro and in vivo testing was performed to demonstrate the feasibility to use retrievable, closed-cell intracranial stents (Enterprise Vascular Reconstruction Device, Cordis Neurovascular, Miami Lakes, FL) for foreign body or clot removal. In vitro testing was performed in an anatomically correct silicone cerebrovascular replica where in three separate trials a 4mm x 8cm GDC Ultra Soft (Boston Scientific Neurovascular, Fremont, CA) was deployed in the superior (M2) division of the right middle cerebral artery (MCA) (n=2) and in the M1 segment of the right MCA (n=1). The stent was deployed partially through a microcatheter around the coil. By advancing the microcatheter and reshaping the stent system, the coil was trapped. Removal of the microcatheter/stent delivery system into the guide catheter resulted in coil removal. Subsequently, the technique was evaluated in a porcine model of intracranial aneurysms, wherein both fresh clot and herniated coils were extracted from the common carotid arteries.

Results
In these experimental procedures, both herniated coils and fresh clot were safely and easily removed from the in vitro and in vivo models. No peri-procedural adverse events were observed. In the tortuous vascular replica, a total of six attempts we required to remove the coils in the three trials (two attempts per successful removal). Multiple attempts were necessary due to the high friction between the silicone model and the devices. In the animal model, two coils herniating from sidewall aneurysms constructed on the carotid artery were removed, each in a single attempt. Moreover, fresh clot that formed spontaneously in the contralateral carotid artery was removed using the same technique (Fig). Microscopic imaging revealed in all trials that the stent did not fracture during either foreign body or clot removal.

Conclusion
These in vitro and in vivo studies suggest the potential utilization of retrievable stents for the removal of foreign bodies or clot from the intracranial circulation.

Key Words: Stent, foreign body removal, thrombectomy
REFERENCES

KEY WORDS: Anterior cerebral artery, fusiform, aneurysm

Poster 160

Endovascular Treatment of Proximal Anterior Cerebral Artery Aneurysms

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PURPOSE
There are few reports on endovascular treatment (EVT) of aneurysms (Ans) arising from the proximal segment of anterior cerebral artery (A1) because of their rarity. We report the angiographic results, clinical outcome and technical aspect of endovascular treatment for 13 A1 Ans with 12 patients.

MATERIALS & METHODS
From January 2002 to November 2007, 12 patients, nine female and three male, visited our hospital with A1 Ans and were treated endovascularly. Among them, three patients presented with SAH and nine patients with 10 aneurysms presented unruptured. All of the Ans were treated successfully with coil embolization. Clinical outcome was available from 1 month to 5 years for all patients. Radiologic outcome was available from 6 month to 5 years for 10 patients.

RESULTS
During the procedure, complications occurred in three patient (25%) comprising one nonangiographic perforation and two thromboembolisms. But all of these complications are not clinically significant. No rebleeding was detected during the follow-up period in the all embolized patients.

CONCLUSION
Endovascular treatment is effective for treatment of A1 Ans. But long term follow-up studies with larger number of patients and comparisons with surgical data were needed.

KEY WORDS: Aneurysm, endovascular, coiling

Poster 161

Role of Oxidative Stress in the Pathobiology of Elastase-Induced Saccular Aneurysms in Rabbits

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PURPOSE
Oxidative stress has been shown to play an important role in many cardiovascular and neurovascular disease states. The aim of this study was to explore the role of oxidative stress in the pathobiology of experimental saccular aneurysms in rabbit.

MATERIALS & METHODS
Elastase-induced saccular aneurysms were created at the origin of right common carotid artery in 12 rabbits. Aneurysm samples and control, unoperated left common carotid arteries were harvested at 2 weeks and at 12 weeks after aneurysm creation. The level of biomarkers of oxidative stress and the activities of antioxidant enzymes were analyzed.

RESULTS
Level of protein carbonyls, an indicator of protein oxidation, was found to be elevated in aneurysm samples at both time points when compared to controls. The oxidative damage to proteins was higher at 2 weeks than at 12 weeks. A statistically significant decline in the activities of antioxidant enzymes superoxide dismutase and glutathione peroxidase was observed at 2 weeks, whereas the activity of catalase, which catalyzes the detoxification of hydrogen peroxide, was elevated at 2 weeks. There was no significant change in the activities of these antioxidant enzymes at 12 week aneurysms.

CONCLUSION
Markers of oxidative stress were altered in the rabbit elastase model of aneurysms at multiple timepoints. Improved understanding of the mechanism of oxidative stress in the biology of aneurysm will provide a way for targeting proteins/pathways for the therapy of saccular aneurysms.

KEY WORDS: Aneurysm, oxidative stress, antioxidant

Poster 162

Endovascular Treatment of Ruptured Vertebral Artery Dissecting Aneurysms with Stent Technique

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PURPOSE
Ruptured vertebral artery dissecting aneurysms were associated with a high incidence of rebleeding and a high mortality rate at the time of recurrent bleeding. We retrospectively analyzed our results of nine cases treated by stent technique and described the efficacy and limitations of this method.
Nine patients with ruptured vertebral artery dissecting aneurysms were treated by endovascular means. Stent placement was used in three patients and stent-assisted coiling in six patients.

**RESULTS**

Stent deployment and coil embolization were carried out without difficulty in all cases. No stent thrombosis and aneurysmal rupture was encountered during treatment. No clinical evidence of rebleeding was seen during the follow-up period (4~39 months) in all patients. Follow-up angiography for 3~18 months was available in six (66.7%) patients. Two cases treated with stent-assisted coiling had recurrence and underwent secondary internal trapping or proximal occlusion. Two cases treated with stent placement got complete resolution and one case remained incomplete resolution.

**CONCLUSION**

Endovascular treatment with stent technique may be a safe and effective therapeutic alternative for ruptured vertebral artery dissecting aneurysms, but close follow up is necessary for these patients. The long-term efficacy of stent technique for these lesions remains to be determined.

**KEY WORDS:** Vertebral artery dissecting aneurysm, endovascular treatment, stent

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**Intraosseous Dural Arteriovenous Fistula of the Petroclival Skull Base: Six Cases Treated with Transvenous Approach**

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**PURPOSE**

Intraosseous dural arteriovenous fistula is a very rare disease entity. We report our experience of the treatment of intraosseous dural arteriovenous fistulas.

**MATERIALS & METHODS**

From 1999 to 2007, six patients (three males, three females) with fistulous channels located within the petroclival bony skull base were treated by transvenous coil embolization. Their images and medical records were reviewed and we describe the fistulous channels with cross-sectional imaging modalities including CT, MR and/or raw data sectional images of 3D angiography.

**RESULTS**

Pulsatile tinnitus was the most frequent symptom which developed in five cases. All arteriovenous fistulas were fed by ascending pharyngeal artery which was the most predominant feeder. Fistulous portions were located at the basiociput of the clivus in five patients and one at the petrous bone. In five clival lesions, erosion of the hypoglossal canal was demonstrated on preembolization CT. Transvenous coil embolization of the intraosseous vascular channel was performed in all cases and the fistulas were occluded completely on angiography and the presenting symptoms disappeared in all. There were no complications related to the endovascular procedures.

**CONCLUSION**

Intraosseous dural arteriovenous fistula of the petroclival skull base is a very rare disease which can be treated successfully and safely with endovascular coil embolization via transvenous approach.

**KEY WORDS:** Dural arteriovenous fistula, intraosseous, transvenous embolization

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**Changes in the Drainage Pattern of Superior Ophthalmic Vein during Transvenous Selective Embolization of Cavernous Sinus Dural Arteriovenous Fistula**

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**PURPOSE**

Cavernous sinus dural arteriovenous fistula (CdAVF) generally is treated by transvenous cavernous sinus packing. Selective transvenous embolization of the fistulous portions has been performed by some authors to our knowledge. However, the flow alteration of superior ophthalmic vein (SOV) during the procedure has not been described in detail. The purpose of this study is to describe the changes of drainage pattern of SOV during selective transvenous embolization of the fistulous portion.

**MATERIALS & METHODS**

Three patients with CdAVF treated with selective transvenous embolization of the fistulous portions were included in this study. Ocular symptoms were caused by abducens, trochlear, or oculomotor nerve palsy. In all cases, the CdAVF had drainage predominantly into the inferior petrosal sinus (IPS). There was neither drain into SOV nor leptomeningeal
venous drainage before treatment. Transfemoral selective sinus embolization of the fistulous portion via IPS was performed in all three patients.

RESULTS
Posterior drainage of the SOV into the cavernous sinus, which was not observed on pretreatment angiography, emerged early in the embolization of the fistulous portion in all three cases. In two cases, angiograms obtained after nearly complete obliteration of the fistula showed markedly increased posterior drainage of the SOV into the cavernous sinus. In the remaining one case, angiogram at the end of the procedure showed incomplete obliteration of the fistula. Follow-up examination revealed complete disappearance of CdAVF in all three cases. Radiographic cure of the fistula resulted in clinical cure in two patients and stabilization in another patient.

CONCLUSION
Decreased venous pressure due to proper embolization of targeted fistulous portions probably contributed to emergence of normal posterior drainage of the SOV into the cavernous sinus. Posterior drainage of the SOV into the cavernous sinus may predict technical success. Selective transvenous embolization of the fistulous portion requires attention to changes in the venous outflow that occur during therapy. For example, inadequate obstruction of outflow into IPS before sufficient reduction of shunt flow can redirect venous flow (i.e., emergence of dangerous anterior drainage into SOV), and convert a more benign lesion into one with more severe ocular symptoms. We must not confuse prominent normal posterior drainage of the SOV into cavernous sinus with emergence of dangerous anterior drainage into SOV.

KEY WORDS: Dural arteriovenous fistula, cavernous sinus, transvenous selective embolization

Poster 165
Utility of C-Arm Fluoroscopic Cone Beam Angiographic CT in Minimally Invasive Spine Interventions

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PURPOSE
CT and biplane fluoroscopy are standard techniques commonly used for real-time imaging guidance of percutaneous spine interventions and surgery of the head and neck. These methods have distinct advantages but also significant limitations. CT allows imaging in the axial plane and 3D reconstruction of data during the procedure; however, patient access and positioning is suboptimal due to the physical constraints of the scanner and limited planar imaging and spatial resolution. Conventional fluoroscopy enables improved patient access and positioning, but only provides planar images for guidance. To address these limitations some have registered preoperative CT images with real time 2D fluoroscopy but this technique has inherent difficulties with registration precision. Isocentric C-arm fluoroscopic cone beam CT (CBCT) is a new technique which offers the advantages of CT imaging guidance with the improved patient positioning and access of C-arm fluoroscopy. Compared to conventional CT, CBCT has improved spatial resolution because it is a true 3D volume acquisition of data. C-arm fluoroscopic cone beam CT has lower dose than conventional CT, allowing acquisition of multiple cone beam CT data sets during an intervention. The purpose of this study was to investigate the utility of CBCT in the guidance of minimally invasive percutaneous spinal and paraspinal procedures.

MATERIALS & METHODS
Five patients were referred for minimally invasive percutaneous spinal and paraspinal interventions, including: vertebral bone biopsy (2), vertebroplasty, paraspinal abscess drainage, and paravertebral fiducial marker placement for radiotherapy. Imaging guidance for these procedures was performed utilizing the AXIOM Artis biplane C-arm fluoroscopy system (Siemens Medical Solutions) equipped with cone beam CT technology and high-resolution flat panel detectors.

RESULTS
Intraoperative CBCT imaging guidance enabled precise, accurate, placement of operative hardware during the performance of a wide range of percutaneous spinal and paraspinal interventions leading to good patient outcomes and no procedure-related complications.

CONCLUSION
Cone beam angiographic CT using orbital C-arm fluoroscopy equipped with the latest generation flat panel detectors is a promising new technique for intraoperative 3D imaging guidance of minimally invasive interventional procedures such as vertebral bone biopsy, vertebroplasty, paraspinal abscess drainage, and fiducial marker placement. The many advantages of CBCT include excellent spatial and contrast resolution, rapid data acquisition and reconstruction allowing near real time 3D guidance, improved patient positioning and access, and reduced exposures to patient and
staff. These advantages enable accurate placement of operative hardware leading to improved outcomes and reduced risk of procedure-related complications.

**KEY WORDS**: Intervention, vertebroplasty, fluoroscopy

**Poster 166**

**Study of Conformability of the New LEO+ Stent to a Curved Vascular Model Using Flat-Panel CT**

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**PURPOSE**

In a previous study we assessed the conformability limitations of self-expandable stents to a curved vascular model. The LEO stent, one of the current self-expandable stents available for intracranial aneurysm treatment showed two adverse mechanics: flattening of the stent midsection and inward crimping of proximal and distal ends (fish-mouth phenomenon). Both are potential sources for technical or clinical complications. We present a follow-up study, in which we evaluate the conformability of a second generation stent (LEO+).

**MATERIALS & METHODS**

A 3.5 mm x 25 mm LEO+ stent (Balt Extrusion, France) was deployed inside a 3 mm x10 cm polytetrafluoroethylene (PTFE) tube (vascular model) with a 5 mm opening (aneurysm neck) at its midsection. The PTFE tube then was placed in a styrofoam block and bent at different angles ranging from 0° to 150°. For each angle, a rotational radiogram (C-arm FP-CT, DynaCT) was performed using a C-arm angiographic system (Axiom Artis dBA, Siemens Medical Solutions, Forchheim) with the following protocol: 23 s rotations, increment 0.80°, 166 projections, 2480 x 1920 matrix (2K). Three dimensional reconstructions were performed using a commercially available workstation (Leonardo, Siemens Medical Solutions, Forchheim) and the following mode: manual, minimal voxel size (ranging from 0.065 to 0.087 mm), 512 x 512 matrix, kernel: bone sharp. Maximum intensity projections (MIP) of 5 mm and 1 mm thickness were used for evaluation of the stent bendings. The reconstructions obtained were compared to those previously obtained using the first generation LEO stent.

**RESULTS**

The 5 mm MIPs allowed for a complete visualization of the entire stent. Using 1 mm thickness MIPs, a more detailed evaluation of the stent was possible, enabling an “in-stent” along the entire length of the device. The LEO+ stent showed symmetric deployment at all degrees of curvature tested without flattening or kinking. The stent retained its round cylindrical shape at all curvatures without inward crimping of its proximal and distal ends.

**CONCLUSION**

Adverse mechanisms of the LEO stent as previously observed in a curved vascular model, could not be documented with the new LEO+ stent, suggesting better conformability to curved or tortuous vasculature due to design improvements.

**REFERENCES**


**KEY WORDS**: LEO+ stent, conformability, mechanics

**Poster 167**

**Resolution Limits of Current Flat Panel Computed Tomography for Computational Hemodynamics Simulations in Intracranial Stents**

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**PURPOSE**

Evidence suggesting that alterations in wall shear stress (WSS) due to stent implantation contribute to in-stent restenosis, has motivated the use of computational hemodynamics (CHD) for the study of blood flow in stents. This study modeled blood flow using a realistic geometry acquired from a in vitro deployed self-expanding intracranial stent using the highest spatial resolution currently available for clinical imaging: flat panel computed tomography (FP CT).

**MATERIALS & METHODS**

A 3D reconstruction of a 3.5 mm x 20 mm Neuroform 3 (NF3) stent (Boston Scientific, Fremont, CA) deployed inside a straight 4 mm polytetrafluoroethylene (PTFE, WL
Gore & Associates, Inc., Newark, DE) tube was obtained from FP CT (Artis dBA, Siemens Medical Solutions), using the following parameters: 23 sec rotation, 166 projections, 1920 x 2480 (2K) matrix providing 150 µm spatial resolution (0.017LP/mm). These data were subjected to a segmentation algorithm, from which the stent and wall computational mesh was generated.

**RESULTS**

Three-dimensional reconstructions, based on FP CT showed exaggerated stent strut dimensions due to “blooming” effects and partial volume averaging, and artificially roughened “vessel walls”. Computational hemodynamics simulations-based computational meshes show blood flow that is artificially disturbed near the wall, generating false stagnation zones and WSS that are amplified above correct values and exhibit artificial heterogeneity when compared with high resolution idealized model simulations. Nonconnecting strut vertices appear falsely connected and locations, where struts prolapse into the lumen are incorrectly resolved as increased strut diameter and/or merger.

**CONCLUSION**

Current spatial resolution of FP CT appears insufficient for realistic CHD studies in small intracranial stents, even when using 2K imaging. With a modest increase in FP CT spatial resolution through both, hardware and software improvements, the productive use of CHD in clinical applications for assessing blood flow in small intracranial stents could be realized in the near future.

**KEY WORDS:** Wall shear stress, flat panel CT, stent

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**Poster 168**

**Palm-Sized Light Weight CT and MR Compatible Whole Body Stereotactic Image-Guided Needle Placement Device**

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**PURPOSE**

To develop a light weight stereotactic device, that is both CT and MR compatible, that is suitable for use in patients of all ages and can be utilized for procedures in entire body including brain, thorax and abdomen.

**MATERIALS & METHODS**

A mechanical device has been developed that is made out of light weight material that is both CT and MR compatible, has fiducial markers detectable on both CT and MR, and has mechanism that allows quick release of the needle after placement, so as to allow free breathing for the patient. This feature allows utilization of this device in chest and abdomen also. The device can be placed on the skin or on the exposed organ during surgery. The target and the safe path for the needle are obtained from CT/MR imaging. The depth of needle placement and setting up the device so as to direct the needle along the desired path is obtained by entering the coordinates of site of entry and target site in a specially designed software program or by using a specially designed mechanical simulator frame.

**RESULTS**

The device has been used in human subjects with 100% success, in brain, lung and abdomen. The accuracy of needle placement is within a radius of 5 mm from the desired target point in brain and within a radius of 5 mm from the desired target point in lung and abdomen.

**CONCLUSION**

1) The device enables precise placement of needle in the desired location anywhere in the body, including in parts that move on respiration such as chest and abdomen. 2) Positioning of the needle can be in a direction other than the axial plane. 3) Reduction of number of attempts to place the needle in desired location along the desired path minimizes the morbidity and mortality of the procedure. 4) This device can be utilised to position a needle/medical device for obtaining tissue samples, for delivering drugs/energy or for therapeutic/palliative aspiration of fluid collections.

**KEY WORDS:** Stereotactic device, CT compatible, MR compatible
**Poster 169**

**Supplementary Device for Vertebroplasty Procedure in Angiography Suite**

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**PURPOSE**
The high quality of bi-plane angiography suite is important for vertebroplasty procedure. However, the table usually is not comfortable for patient in prone position. A more comfortable device was designed to relieve the patient’s uncomfortable sensation and allow the procedure to be performed under more cooperative conditions.

**MATERIALS & METHODS**
To solving the problem during the procedure of vertebroplasty including: 1) better feeling of security (make a wider base for the patient with same material that is used for x-ray tables); 2) more comfortable for the shoulder (with the wider base, we design a hand-rail for the patient); 3) more comfortable respiration (make a shallow space for the stomach and lower abdomen); 4) more comfortable face positioning (make a hole in the right position and let patients put their faces inside the hole to breath easily). The time between application of local anesthesia and the first time the patient called for assistance or started to move and the oxygen level in the monitor were recorded.

**RESULTS**
Compared before (group A, n = 10) and after (group B, n = 10) application of such device, patient could remain immobile for only 8. 4 ± 7.4 minutes and 20.5 ± 10. 8 minutes respectively in group A and B. Their mean oxygen level was relatively higher in group B though there was no statistically significantly different. The procedure time was relatively shorter in group B (p < 0.05).

**CONCLUSION**
Both patient and operator can benefit from a supplementary specially designed device for the patient receiving vertebroplasty.

**KEY WORDS:** Vertebroplasty, device, patient

**Poster 170**

**3D Multiphasic Low-Dose Contrast-Enhanced MR Angiography Using TWIST at 3 T: Comparison of a Conventional vs High Relaxivity Gadolinium Chelate**

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**PURPOSE**
With the recognition of nephrogenic systemic fibrosis (NSF), gadolinium (Gd) chelate administration in patients with renal failure has become a major concern, and in particular accumulated dosage of Gd contrast. The purpose of this investigation was to explore the possibility of low dose, contrast-enhanced magnetic resonance (MR) angiography technique with high temporal and spatial resolution.

**MATERIALS & METHODS**
Eleven male New Zealand White rabbits were evaluated with contrast-enhanced MRA (TWIST: TR/TE = 2.5/1.1, 1.2 x 1 x 1 mm³ voxel size, IPAT = 3, TA = 1.05 sec), examining the abdominal vascular structures at 3 T using a prototype 32-channel head coil. Two different contrast media, 1) gadobenate dimeglumine and 2) gadoteridol, were injected in separate sessions (> 24 h) using a MedRad power injector (0.04 mmol/kg contrast dose). Quantitative analysis was performed by placing a circular region of interest in the aorta at the level of the renal bifurcation and another in the adjacent tissue to assess the contrast-to-noise (CNR).

**RESULTS**
All 11 rabbits were evaluated successfully twice with multiphasic MRA using TWIST. Significantly higher maximum signal intensity (~25-30%) was found in the aorta with gadobenate dimeglumine compared to gadoteridol (p = 0.001) (Fig). The improved CNR also led to an improved depiction of peripheral vessels, while using almost 1/3 of the normal contrast dose.

**CONCLUSION**
The utilization of higher field strength, improved coil design, and higher relaxivity contrast media permits high quality, low dose contrast-enhanced MR imaging, representing a possible approach to address the concern of NSF.

**KEY WORDS:** Contrast-enhanced MRA, 3 T, NSF
Extended Intracranial Applications for Ethylene Vinyl Alcohol Copolymer (Onyx)

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PURPOSE
Onyx™ is currently approved by the U.S. Food and Drug Administration for the treatment of brain arteriovenous malformations (AVMs). Previous reports have established a role for liquid embolics such as n-BCA for the treatment of high-flow intracranial arteriovenous (AV) fistulas and fusiform aneurysms (1-3). The advantage of Onyx™ compared with flow intracranial arteriovenous fistulas and fusiform mycotic and dissecting aneurysms. Previous reports have established a role for embolization of intracranial high-flow arteriovenous fistulas and fusiform mycotic and dissecting aneurysms.

MATERIALS & METHODS
Retrospective chart and imaging review of five patients treated at the University of Utah Hospital in 2007.

RESULTS
Patient demographics, lesion type, embolic material used and technical results are summarized in the Table. Technical success in occluding the target vessel/aneurysm was achieved in all patients. There were no clinical complications. In both cases of AV fistulas treated with a combination of Onyx™ and detachable coils, some liquid embolic penetrated the coils into the venous system.

Table. Patient Demographics, Lesion type, and Technical details

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Sex</th>
<th>Lesion</th>
<th>Embolic</th>
<th>Target vessel occlusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>F</td>
<td>Pial AV fistula</td>
<td>Onyx-34 + detachable coils</td>
<td>Yes</td>
</tr>
<tr>
<td>53</td>
<td>F</td>
<td>Mycotic aneurysm</td>
<td>Onyx-18</td>
<td>Yes</td>
</tr>
<tr>
<td>68</td>
<td>F</td>
<td>Mycotic aneurysm</td>
<td>Onyx-18</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>Dissecting aneurysm</td>
<td>Onyx-18</td>
<td>Yes</td>
</tr>
<tr>
<td>49</td>
<td>F</td>
<td>Vein of Galen malformation</td>
<td>Onyx-34 + detachable coils</td>
<td>Yes</td>
</tr>
</tbody>
</table>

CONCLUSION
Onyx™ can be used safely to achieve occlusion of intracranial high-flow AV fistulas and fusiform aneurysms. A moderately dense initial coil packing of AV fistulas should be achieved prior to injection of Onyx™ to prevent penetration into the venous system.

REFERENCES

KEY WORDS: Onyx, fusiform aneurysms

Preoperative Onyx Embolization of Aggressive Vertebral Hemangiomas

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PURPOSE
We report the first use of Onyx in the embolization of spinal tumors - two cases of aggressive vertebral hemangioma.

MATERIALS & METHODS
In both cases, initial imaging work up demonstrated solitary lytic vertebral lesions extending into the canal, at T8 and L2 respectively; the latter causing cauda-equina compression. One patient already underwent open tumor biopsy with resulting blood loss of 3,500 ml. Preoperative embolization was attempted after superselective catheterization of the relevant feeding vessels. Particulate injection of Embospheres (BioSphere Medical, Rockland, MA) was the agent of choice in both cases but resulted in minimal devascularization after prolonged injections of up to 1 hour. Onyx (eV3, Irvine, CA) then was used through the same vascular pedicles with resulting well visualized embolizations penetrating the tumor beds over relatively short periods of time. In one case we allowed considerable reflux of Onyx along the microcatheter without troublesome catheter adhesion. In the second case, the tumor was flooded almost completely with Onyx (Fig) resulting in an almost bloodless surgical resection (100 ml total blood loss) and histopathology demonstrated Onyx-penetration of parenchymal hemangioma vessels.

RESULTS
Safe particulate embolization requires large volumes and slow injection rates, resulting in lengthy injection and fluoroscopic times. Despite suspension in iodinated contrast, passage of radiolucent particles through small but dangerous collateral vessels may go unnoticed. Kim et al. described liquid NBCA-embolization of vascular head, neck and spine tumors. They recorded only one temporary embolic complication in a series of 35 patients. Although tumor penetration and infarction were documented, its efficacy in limiting blood loss was not control matched. NBCA injections were fast, permanent and well visualized, but required technical expertise and risked catheter adhesion. Reports of Onyx tumor-embolization are limited. Gobin et al. used EVAC to embolize 14 head and neck tumors with only two temporary adverse events. Advantages over NBCA included more controlled gradual injections and they had no cases of catheter entrapment.

CONCLUSION
Onyx can be used to safely embolize highly vascular tumors and has the advantages of good visibility, control and shorter injection times compared to particulate agents such as Embospheres or PVA. Our cases add to the few descriptions of Onyx use in tumor embolization and are the first documented use of Onyx in the treatment of spinal tumors. As the neuro-endovascular community becomes more familiar with Onyx through its use in cerebral AVMs, its application to other areas such as this should become more widespread.

KEY WORDS: Onyx, hemangioma, embolization
Repeatability of High-Resolution CT after Carotid Stenting: A Vessel Phantom Study

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PurPSe
After carotid artery stenting, it is commonly accepted that neointimal hyperplasia or recurrent atheromatous plaques are cause of restenosis. To detect the primary change of the restenosis, which is expressed as intraluminal low dense substance, we should know the characteristic of the carotid stent itself. However, there was no previous report that evaluates characteristics of the metallic stent and intraluminal substances on high-resolution CT images. In a present study, by using vessel phantom, we aimed to examine the characteristics of the carotid stent and reliability of CT scan by varying collimation thickness, and angles toward the gantry.

Materials & Methods
We used two types of clinically used 10 mm diameter carotid stent (WALLSTENT, 10 mm diameter, Boston Scientific Co.; Precise stent, Cordis, a Johnson & Johnson company). Each vessel phantoms opacified with 400 Hounsfield Unit (HU), which were covered with stent and were in the same diameter, were sunk in the filled water. These phantom sets were scanned with multidetector CT (Aquilion 64, Toshiba, Japan) using following condition, 120 kV, 50 mA, 0.5 s/rot, helical-pitch: 41, kernel: FC43. We also made the 50% stenosed phantom using plaque models. As a control, phantoms without stent also were scanned. Three experienced neuroradiologists evaluated imaging quality independently of the intraluminal substances about 60 HU than that without stent. On the other side, Precise stent showed decreased HU of the intraluminal substances about 60 HU than that without stent. On the other side, Precise stent showed decreased about 25 HU. Compared with other condition, imaging quality was the best when 0.5 mm collimation. Scanning with 0.5 mm collimation, imaging quality was maintained in all degrees. Examined with profile-curve, WALLSTENT had higher HU than that of Precise and intraluminal changes were more obscured by stent halation.

Results
Using kernel FC43, WALLSTENT showed 2400 HU and Precise stent showed 1080 HU. WALLSTENT enhanced HU of the intraluminal substances about 60 HU than that without stent. On the other side, Precise stent showed decreased about 25 HU. Compared with other condition, imaging quality was the best when 0.5 mm collimation. Scanning with 0.5 mm collimation, imaging quality was maintained in all degrees. Examined with profile-curve, WALLSTENT had higher HU than that of Precise and intraluminal changes were more obscured by stent halation.

Conclusion
In a present study, optimal scanning condition to observe the intraluminal changes on high-resolution CT images were provided. Less than 1 mm collimation may provide clear intraluminal changes in any degrees toward gantry. However, WALLSTENT tended to obscure the primary changes of restenosis on CT images than that of Precise stent. There is higher possibility to underestimate the luminal stenosis, when WALLSTENT is used. Evaluating intraluminal changes, we have to take stent types into consideration.

Key Words: Carotid stent, CT, phantom
**Poster 175**

**Treatment Strategy Based on Multimodal Management**

**Outcome of Cavernous Sinus Dural Arteriovenous Fistula**

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**PURPOSE**

Progressive restrictive change of venous drainage (angiographic type) in cavernous sinus dural arteriovenous fistula (CSDAVF) can not only affect the presenting symptom pattern (PSP), but also can modify the strategy regarding the choice of treatment modality. We evaluated the outcome of CSDAVF according to the PSP and the type of treatment in order to propose a treatment strategy for each disease phase according to the different venous drainage patterns.

**MATERIALS & METHODS**

Ninety consecutive patients (M:F = 24:66; age range 20-80 years, mean 57 years) were included in this study. We evaluated the PSPs (orbital, cavernous, ocular, and cerebral symptoms), angiographic type (proliferative, restrictive or late restrictive), mode of treatment (embolization, gamma knife radiosurgery (GKS), or conservative management), mode of embolization (transarterial or transvenous), and final clinical status (cure, improvement, aggravated and no change). The mean follow-up duration was 17 months. We compared each group’s outcomes according to the PSPs, angiographic types, treatment types, and embolization routes using the chi-square test or Fisher’s exact test.

**RESULTS**

Ninety patients with 34 proliferative, 40 restrictive, and 16 late restrictive types of PSP were treated by embolization (n = 64), GKS (n = 7), and conservative management (n = 19). The cure and improvement rate was 50% (32/64) and 41% (26/64) after embolization, 43% (3/7) and 29% (2/7) after GKS, and 47% (8/19) and 41% (7/19) during conservative treatment. Following embolization, 100% of 24 proliferative types, 87% of 30 restrictive types, and 90% of 10 early restrictive types were cured or improved. The PSPs demonstrated cavernous (70%), orbital (60%), ocular (59%), and cerebral (7%) symptoms in order of frequency. No statistically significant difference was found in the distribution of PSPs between an angiographic type or in the outcomes according to the PSPs. In 43 patients who underwent transvenous embolization, the cure and improvement rate were 60% (26/43) and 40% (17/43) compared with 27% (6/21) and 45% (10/21) in the 21 patients who underwent transarterial embolization (P = 0.003).

**CONCLUSION**

Various factors of PSP, the angiographic type, and the mode of treatment should all be considered in order to obtain a more favorable final outcome for CSDAVF. The successful results obtained by embolization revealed that embolization using a venous approach can lead to a more complete cure than the use of an arterial approach.

**KEY WORDS:** Arteriovenous fistula, angiography

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**Poster 176**

**High-Dose Intraarterial Infusion of Verapamil is Safe and Effective for the Treatment of Cerebral Vasospasm Resulting from Subarachnoid Hemorrhage**

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**PURPOSE**

Verapamil is a calcium channel blocker and has been used intraarterially to treat cerebral vasospasm resulting from subarachnoid hemorrhage. A previous study reported on the use of low dose verapamil, the average dose given being 3 mg and the single largest dose given was 8 mg (1). We report our experience with high-dose verapamil in the treatment of vasospasm.

**MATERIALS & METHODS**

From December 2005 to June 2007, we treated 26 patients with verapamil for symptomatic cerebral vasospasm. The age range was 26 to 75 years, with a mean of 48 years. A total of 35 treatments were given in the 60 arterial territories, (six patients received two or more treatments). The spasm was severe in 31, moderate in 26 and mild in three patients. Typically 10 mg of Verapamil was injected over 1 minute in a single arterial territory. The doses used ranged from 5 to 30 mg, with a mean of 10.6 mg.

**RESULTS**

In 46 arterial territories (76%) a satisfactory response with moderate improvement in the flow and caliber of arteries was noted. In 13 arterial territories (22%) additional treatment by balloon angioplasty was required. In one arterial territory (2%) balloon angioplasty and papavarine infusion was used. In all patients verapamil was tolerated well. Transient changes in blood pressure, pulse and intracranial pressure did not require additional treatment.

**CONCLUSION**

A high-dose of verapamil can be used safely and effectively to treat cerebral vasospasm. Some patients with severe vasospasm may need additional treatment such as balloon angioplasty.

**REFERENCES**


**KEY WORDS:** Verapamil, vasospasm, subarachnoid hemorrhage
Poster 177

CT Evaluation of the Feasibility Caudal Access as a Novel Approach to Percutaneous Intraspinal Navigation through the Sacral Hiatus

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Purpose
Percutaneous intraspinal navigation (PIN) is a new procedure that enables visualization of the central nervous system using a lumbar puncture technique. Past research shows promising potential, but is limited by damage to expensive fiberscopes due to the sharp angle of manipulation at L3-L4. Our objective in this study is to analyze the feasibility of a novel access through the sacral hiatus to eliminate this problem.

Materials & Methods
We retrospectively reviewed CT images of the sacrum of 132 subjects, of which nine were excluded either secondary to incomplete imaging of the sacrum or variant anatomy that precluded any possible measurements. Of the remaining 123 patients, we measured kyphotic and lordotic curvature of the sacral canal in comparison to the angle of lumbar puncture. We also measured the AP diameters of the sacral canal at the distal, middle, and proximal portions.

Results
There were no significant differences according to sex or age. The kyphotic angle was a wide angle with a mean value of 167.89° ± 11.71°. The lordotic angle had a mean value of 133.35° ± 7.84°, making it 25.52° more obtuse than the average angle for lumbar puncture. The smallest diameter of the sacral canal was at the sacral hiatus and had a mean value of 4.49 ± 1.66 mm.

Conclusion
The size and anatomy of the sacral canal is feasible for PIN procedure and appears more favorable as compared to entry via lumbar puncture. The canal opening is wide enough to accommodate most small diameter fiberscopes without difficulty, and the angles are obtuse enough to limit damage to the expensive fiberscopes.

Key Words: Percutaneous intraspinal navigation, sacral hiatus, PIN

Poster 178

Impact of Injection Parameters on Arterial, Capillary and Venous Opacification in Digital Subtraction Angiography

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Purpose
Currently available flat detector angiographic equipment has greatly improved the potential for quantitative assessment of aspects of cerebral hemodynamics. The validity of such measurements is dependent upon an understanding of factors affecting arterial, capillary (tissue) and venous opacification following an intra-arterial injection of contrast. It was our purpose to evaluate the effect of these factors using a canine model.

Materials & Methods
Under an institutionally approved protocol, 5 canines underwent selective carotid angiography using a 5F catheter placed in the common carotid artery. All studies were performed using general anesthesia with controlled respiration and constant monitoring of heart rate and oxygen saturation. Sequential biplane angiographic acquisitions were obtained during 5 injection protocols using a biplane flat detector angiographic system (Artis dBA Siemens Medical Solutions). The effect of contrast volume, concentration, injection rate, injection duration, and catheter position were examined independently. Prototype software allowed for evaluation of blood flow using DSA acquisitions (Siemens Medical Solutions). This program produced time-density curves of a contrast bolus at a selected position on the image and calculated specified characteristic parameters describing the height and width of the curve (such as half-time of wash in, start of maximum increase, time of peak, half-time of wash out and end of maximal decrease). These may then be displayed on a parametric map. The result from each injection protocol was evaluated by analyzing the time-density curves at points in the common carotid artery, the jugular vein and brain parenchyma. Since there was no movement of the animal or the angiographic table during these acquisitions, the points were the same on all images from each injection protocol thus allowing image to image comparison of the curves.

Results
Changes in injection protocol resulted in predictable changes in the time-density curve. The most important parameter contributing to maximum opacification was the volume injected. There was an increase in opacification proportional to the injected volume. In addition, volume had an indirect (secondary) impact on the temporal characteristics of the opacification, i.e. the curve became wider and the peak was shifted to the right as the injection duration was increased. Increasing the injection rate resulted in a leftward shift of the peak while increasing the duration of injection resulted in a broadened peak. Increasing the concentration of contrast medium resulted in a non-proportional increase in the height of the curves only. Catheter position did not cause significant
alterations in the shape of the curves. Trends in the results were similar regardless of the site of measurement i.e. artery, capillary bed, vein and were consistent among all subjects.

**CONCLUSION**

This study shows that there is a predictable effect of injection parameters on the contrast bolus geometry as well as on time-density curves as measured in artery, capillary bed or vein using flat detector angiography. The amplitude of the curve depends mainly and proportionally on the volume of contrast injected. This proportional dependence is most obvious when measured in the parenchyma i.e. capillary bed. Curve width is most dependent on the duration of the injection.

**KEY WORDS:** Angiography, Bolus, Geometry

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**Poster 179**

**Arteriovenous Shunting as a New Feature of PHACES Syndrome: A Case Report**

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**PURPOSE**

PHACES syndrome is a rare congenital disorder. The spectrum of clinical findings includes Posterior cranial fossa malformations, Hemangiomas, Arterial anomalies, Coarctation of the aorta and cardiac defects, Eye abnormalities, and Sternal and supraabdominal raphe defects. The currently reported intracranial vascular anomalies associated with this syndrome are all arterial in nature, consisting of agenesis of major cervical arteries, embryologic persistence of arteries, arterial stenoses, dilatative arteriopathy, and aneurysms. We report a unique case of a 3-month-old girl with PHACES syndrome and a mixed pial-dural arteriovenos fistula (AVF) of the posterior fossa.

**MATERIALS & METHODS**

Our patient with PHACES syndrome presented at 3-month of age with an aggressive subglottic hemangioma, resulting in respiratory distress, intracranial arterial anomalies (an atretic right internal carotid artery and an azygos anterior cerebral artery), and a mixed pial-dural AVF of the posterior fossa. A much-enlarged right anterior inferior cerebellar artery supplied the pial component of the AVF, shunting into the right sigmoid sinus through several large cortical veins (1A and B). Multiple branches of the right external carotid artery, particularly of the middle meningeal artery, supplied the dural component of the AVF, shunting into the dural sinus at the right transverse-sigmoid junction (1C and D).

**RESULTS**

Representing the dominant lesion with a much higher flow of arteriovenous shunting, the pial component was treated successfully with coil embolization at 8 months of age (1E and F), shortly after the surgical resection of the subglottic hemangioma allowed for safe control of the patient’s airway.

**CONCLUSION**

Although the intracranial vascular anomalies associated with PHACES syndrome span a wide spectrum, it is striking that all of the currently reported variations are arterial in nature, while the underlying abnormalities for other neurocutaneous syndromes, such as the cerebrofacial arteriovenous metameric syndrome and the Sturge-Weber syndrome, appear to be in capillaries and veins. Our case represents the first description of the association of arteriovenous shunting with PHACES syndrome. Because arteriovenous malformations are believed to be of venous origin, our case suggests that the underlying abnormalities of the syndrome may not be purely arterial. This may further shed light on the timing of the onset and the pathophysiology underlying the syndrome.

**KEY WORDS:** PHACES syndrome, arteriovenous shunting, mixed pial-dural AVF
Poster 180

Griscelli Syndrome: A Case Report and Review of the Literature

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PURPOSE
We present a rare case of Griscelli syndrome with involvement of the central nervous system and review the existing English language literature. Typical and atypical neuroimaging findings on a series of CTs and MRIs will be discussed.

MATERIALS & METHODS
A 3 1/2-year-old previously healthy boy was admitted to our institution after his third episode of fever in 3 month time. Extensive work up ensued including a bone marrow biopsy which revealed the presence of occasional hemophagocytic histiocytes. The presence of silvery hair was noticed and a presumptive diagnosis of Griscelli syndrome was made. During hospitalization, seizure activity was noticed which led to a series of brain MRIs performed with multiplanar FLAIR, DWI, pre and postcontrast T1W.

RESULTS
The presence of silvery hair and bone marrow biopsy results showing occasional hemophagocytic histiocytes suggested the diagnosis of Griscelli syndrome. The first brain MRI obtained revealed numerous lesions at the gray-white matter junction in addition to brain stem involvement. A series of follow-up MRI examinations revealed progressive involvement of the cerebral cortex and cerebellum ultimately involving the white matter while sparing the thalami and portions of the basal ganglia.

CONCLUSION
Griscelli syndrome is a rare autosomal recessive disorder with fewer than 10 cases reported in the United States. It is characterized by silvery hair, pigment abnormalities, severe immunologic dysfunction and central nervous system alterations. Fulminant involvement of the brain results in a diffuse loss of cortical and deep hemispheric white matter with relative preservation of the deep gray matter, cerebellum and brain stem. While involvement of the basal ganglia has been mentioned in a prior published case report, the manifestations in the case above were far more extensive and cross at different stages with other more common pathologies.

KEY WORDS: Griscelli syndrome, brain, MRI

Poster 181

Characteristic MR Imaging and MR Angiography Findings of Menkes Disease

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PURPOSE
Menkes Disease (MD) is an extremely rare X-linked recessive disorder of copper metabolism. The incidence is 1 in 140,000 males born in Japan. In order to investigate the characteristics of MRI and MRA readings, we reviewed Japanese patients with MD.

MATERIALS & METHODS
The subjects were seven pediatric patients with MD (five male, two female). All patients were Japanese and underwent MRI and MRA examination at Teikyo University Hospital. Three patients underwent additional MRI during follow up. Four patients were measured in the area of the brainstem on mid-sagittal T1WI, and compared with control subjects.

RESULTS
Thalamic atrophy (3/7 cases), atrophy of the mesencephalic tegmentum (3/7) and abnormal signal changes in the dentate nucleus of cerebellum (4/7) were documented in addition to previously reported findings, such as cerebral atrophy (4/7), cerebellar atrophy (5/7), white matter lesions (4/7), tortuosity of intracranial vessels (5/7), subdural hematoma (3/7) and transient temporal lesions (1/7). Thalamic atrophy, atrophy of the mesencephalic tegmentum and abnormal signal changes in the dentate nucleus of cerebellum tended to be more prominent in children with a long disease history.

CONCLUSION
This study documented new, additional findings namely, thalamic atrophy, atrophy of the mesencephalic tegmentum and abnormal signal changes in the dentate nucleus of cerebellum. Some pathologic studies of MD report that the thalamus and red nucleus are particularly affected, and the Purkinje cells are destroyed showing marked dendritic abnormality in the cerebellum. The results of this study suggest that thalamic atrophy, atrophy of the mesencephalic tegmentum and abnormal signal changes in the dentate nucleus of cerebellum reflect these pathological changes.

KEY WORDS: Menkes disease, MRI, MRA
In AgCC there are widespread microstructural alterations in white matter organization beyond the absence of callosal fibers. Furthermore, the changes are tract-specific, and do not represent a uniform global disruption of white matter microstructural integrity. The specific tracts affected and their hemispheric asymmetry are similar to the findings of prior DTI studies of schizophrenia (2) and autism (3).

**REFERENCES**


**KEY WORDS:** Diffusion tensor imaging, agenesis of the corpus callosum, cingulum

### Poster 183

**Old and New: Supratentorial MR Findings in Chiari II Malformation**

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**PURPOSE**

The Chiari II malformation is a diffuse CNS dysplasia associated with failed closure of the neural tube. Much of the interest in Chiari II malformation has concerned the infratentorial stigmata. In this retrospective study, we use MR imaging to develop an improved morphologic understanding of the abnormalities of the forebrain in Chiari II malformation.

**MATERIALS & METHODS**

Seventy-four patients with Chiari II malformations investigated between 1999 and 2007 were enrolled. Imaging was reviewed retrospectively by two pediatric neuroradiologists with special attention given to diencephalon, midline commissures and hemispheric white matter, and cortex (including the limbic lobe).

**RESULTS**

The massa intermedia was exceedingly large in 63.5%. An abnormal gray matter structure that we called hypothalamic adhesion across the anterior-inferior portion of the third ventricle was noted in 48.6%. The pineal gland could not be identified in 39%; when present, it usually appeared dysplastic and dislocated in the posterior third ventricular wall (6.8%). The anterior commissure was not identified in 4% and was dislocated in a low position in the lamina terminalis in 38%. Gross abnormalities of the corpus callosum/hippocampal commissure, mostly posterior dysplasia-hypoplasia, were found in 57%; they were, however, different from the abnormalities seen in classical commissural agenesis. An abnormal bundle of white matter forming a callosal ridge was noted on the dorsal callosal surface in 60%; it is...
believed to represent the aberrant cingular bundle recently identified using DTI. Hemispheric white matter could be considered as normal in 48%, deficient posteriorly in 55% and globally in 10%. Cortical posterior medial stenogyria was common, observed in 72%. Gray matter heterotopias, mostly periventricular, was found in 19%. The posterior limbic cortex was thin and dysplastic in 46%, characteristically in association with callosal dysplasia (51.5%); hippocampi were commonly abnormal (85%), being symmetrically small, vertical and everted, with abnormal sulcation of the adjacent temporo-mesial cortex (93%).

**CONCLUSION**

Major structural abnormalities were common in Chiari II malformation, and were probably not related to hydrocephalus. As they are important anatomical structures involved in neurocognitive function, those abnormalities should be considered as important factors in the prognostic assessment of Chiari II patients.

**KEY WORDS:** Chiari II, hypothalamic adhesion, callosal ridge

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**Poster 184**

*Abnormal Temporal Lobe Development in Thanatophoric Dwarfism*

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**PURPOSE**

Thanatophoric dwarfism is a lethal form of chondrodysplastic dwarfism. The bony abnormalities associated with thanatophoric dwarfism are well recognized. However, the cerebral abnormalities are not well described on fetal imaging. The aim of this study was to assess the cerebral abnormalities on MR imaging in fetuses diagnosed with thanatophoric dwarfism.

**MATERIALS & METHODS**

We describe the postmortem fetal MR imaging of three cases of thanatophoric dwarfism. The fetuses were of 20, 21 and 23 weeks gestational ages. Following termination of pregnancy, the brains were dissected and fixed in 10% formalin for a period of 2 weeks. The brains subsequently were scanned on 1.5 T MR immersed in formalin. The MR imaging findings were aligned against b = 0 s/mm² images (DW) images (b = 600 s/mm², 32 directions) were acquired using single-shot spin-echo EPI sequence covering the entire brain. To minimize possible residual motion, the DW images were aligned against b = 0 s/mm² image. The transcallosal and pyramidal fiber connectivity was assessed using probabilistic tractography (FSL - Center for Functional Magnetic Resonance Imaging of Brain, Oxford University) (1), and deterministic algorithm using fiber assignment by continuous tracking (DTIStudio - Kennedy Krieger Institute, Johns Hopkins University) (2). The corpus callosum was traced by placing a region of interest (ROI) on a parasagittal plane. The pyramidal fibers were reconstructed by placing the ROIs in the centrum semiovale and cerebral peduncle, respectively (3, 4). The deterministic algorithm was preset to stop if the fractional anisotropy (FA) dropped below 0.20 or the fiber deflection was higher than 70 degrees. The default parameters were used in the probabilistic tractography.

**RESULTS**

On MR imaging, the temporal lobes were enlarged in all three cases. There were increased sulci and gyri with abnormal transverse sulci at the basal temporal lobes. The normal intermediate zone and subplate layer were not visualized in the inferior temporal lobes and the normal hippocampi were not identified on MR imaging. The ventricles were enlarged in two cases. The remaining areas of the brain including the frontal, occipital and parietal lobes were normal. Autopsy confirmed the presence of enlarged temporal lobes with increased convolution and abnormal orientation of the sulci in the inferior temporal lobes in all three cases. The cytoarchitecture of the temporal lobes were abnormal and the hippocampi were dysplastic in all three cases.

**CONCLUSION**

The abnormalities in the temporal lobes of thanatophoric dwarfism were visible in the second trimester on MR imaging. The findings of abnormal cerebral lamination on MR imaging and abnormal cytoarchitecture on autopsy indicated the presence of abnormal development of the temporal lobes in thanatophoric dwarfism.

**KEY WORDS:** Temporal lobe, thanatophoric dwarfism, MRI

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**Poster 185**

*Diffusion Tensor Tractography of White Matter Pathways in Term Newborns: Comparative Study of Deterministic and Probabilistic Tractography*

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**PURPOSE**

Diffusion tensor tractography (DTT) is a noninvasive method capable of delineating white matter pathways in vivo and could provide a new insight into brain maturation. In the neonatal brain, DTT presents several challenges: indeed, at this stage of white matter maturation, myelination is heterogeneous throughout the brain. The aim of this study is to investigate the feasibility of the probabilistic (1) and deterministic (2) tractography methods to show white matter pathways in term newborns.

**MATERIALS & METHODS**

Eight healthy term newborns (3 male, 5 females) were scanned in natural sleep on a Philips Achieva 1.5 T MR scanner using a 6-channel head coil. Axial diffusion-weighted (DW) images (b = 600 s/mm², 32 directions) were acquired using single-shot spin-echo EPI sequence covering the entire brain. To minimize possible residual motion, the DW images were aligned against b = 0 s/mm² image. The transcallosal and pyramidal fiber connectivity was assessed using probabilistic tractography (FSL - Center for Functional Magnetic Resonance Imaging of Brain, Oxford University) (1), and deterministic algorithm using fiber assignment by continuous tracking (DTIStudio - Kennedy Krieger Institute, Johns Hopkins University) (2). The corpus callosum was traced by placing a region of interest (ROI) on a parasagittal plane. The pyramidal fibers were reconstructed by placing the ROIs in the centrum semiovale and cerebral peduncle, respectively (3, 4). The deterministic algorithm was preset to stop if the fractional anisotropy (FA) dropped below 0.20 or the fiber deflection was higher than 70 degrees. The default parameters were used in the probabilistic tractography.

**RESULTS**

In all examined healthy term newborns we observed that deterministic DTT reconstructed the pyramidal tracks in an asymmetric way. The left-side tracks appeared to be formed by fewer fibers and both tracks hardly arrived to the motor cortex. In the same way for the chosen FA threshold, the corpus callosum was not well defined regarding its anatomical components. Moreover, not all fibers penetrated equally into the subcortical white matter. On the contrary, in case of probabilistic DTT, both pyramidal tracks and corpus callosum were fully depicted.
CONCLUSION
The preliminary results obtained from this small population suggest that probabilistic DTT may provide more complete reconstruction of the white matter fibers compared to deterministic DTT. Probabilistic tractography could be therefore the method of choice in studying brain maturation.

REFERENCES

KEY WORDS: Diffusion tensor tractography, probabilistic, deterministic

Poster 186
Role of MR Imaging in Prenatal Diagnosis of Facial Clefts

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PURPOSE
The aim of the study was to investigate the role of magnetic resonance imaging (MRI) in prenatal diagnosis of facial clefts.

MATERIALS & METHODS
During a 7-year period (2001-2007) in 32 pregnant women with a mean gestational age of 27 weeks (range 21-35) who underwent in utero MRI, (1.5 T, cardiac coil, T2-weighted ultrafastspin-echo sequences, echoplanar sequences, steady-state free precession sequences, in 3 orthogonal planes, 2-4 mm slice-thickness) a facial cleft was diagnosed. In these cases previous ultrasound had identified a malformation in any part of the body. Clefts were classified into four categories: cleft lip alone; unilateral cleft lip and palate; bilateral cleft lip and palate; bilateral cleft lip and palate and midline cleft lip and palate. The postnatal diagnosis and the severity of the cleft malformation were assessed by the operating surgeon and the results were compared with intrauterine MRI findings.

RESULTS
We investigated five (5/32; 15.6%) isolated cleft lips, 14 (14/32; 43.8%) unilateral, eight (8/32; 25.0%) bilateral and one (1/32; 3.1%) midline cleft lip and palate. In two (2/32; 6.3%) cases the malformation was suspected only by ultrasound examination and could not be verified by MRI. Isolated palate clefts (n = x) were not seen by ultrasound (Fig. coronal sections: 1a: T2-weighted image showing a right palatal cleft). Seven (7/32; 21.9%) neonates died postpartum because of associated severe anomalies. One fetus died in utero and one pregnancy was terminated after diagnosis. Two fetuses with a cleft lip and palate have not been delivered yet. The MR classification of the cleft lip and palate correlated with severity of defect and postnatal diagnosis in all but one case. In this case an isolated cleft lip and palate was diagnosed at a gestational age of 33 weeks. The patient delivered a healthy child.

CONCLUSION
Fetal MRI allows detailed prenatal evaluation of the upper lip and palate, allowing a better staging of the malformation by detecting the degree of involvement of the palate. In addition isolated palate clefts which may not be accessible by ultrasound, can be visualized.

KEY WORDS: Prenatal imaging, MRI, facial clefts

Poster 187
Long-Term Outcomes in Patients with Intracranial Germinomas: A Single Institution Experience of Irradiation with or without Chemotherapy

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PURPOSE
Complete remission can be achieved soon after irradiation in patients with intracranial germinoma. This study aims to analyze the follow-up outcome of intracranial germinoma patients.

MATERIALS & METHODS
Thirty-nine intracranial germinoma patients (29 males and 10 females; average age, 15 years; range, 7-27 years) treated at Kyoto University Hospital from 1978 to 2004 were included in the study group. Thirteen patients were treated with craniospinal axis irradiation, six with whole-brain irradiation, 17 with whole-ventricle irradiation, and three with local field irradiation. Since 1997, 15 patients were treated with reduced-dose whole-ventricle irradiation (median, 23.4 Gy; range, 20.4-27 Gy) followed by a local boost (median, 40.8Gy; range, 36-54Gy) combined with chemotherapy. The median follow-up was 94 months (18 months to 25 years).

RESULTS
The 5- and 10-year overall survival (OS) rates of the entire group were 97 and 90%, respectively. The 5- and 10-year progression-free survival (PFS) rates of the entire group were 91 and 87%, respectively. The 8-year OS and PFS in the 15 patients treated by whole-ventricle irradiation combined with chemotherapy were 100 and 92%, respectively.
Four patients had recurrences within a median period of 59.5 months (51 to 85 months). All relapses occurred outside the radiation fields.

**Fig. 1**

PFS

**CONCLUSION**

All initial recurrences of intracranial germinoma occurred at a distant site from the radiation field. Our data suggested that reduced radiation therapy doses to the whole ventricle, combined with chemotherapy, should be sufficiently effective in patients with intracranial germinoma.

**KEY WORDS:** Intracranial germinoma, recurrence, radiotherapy

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**Poster 188**

**Unusual Presentations of Common Lesions and Common Presentations of Unusual Lesions in Children**

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**PURPOSE**

To present some unusual imaging manifestations of common lesions (e.g., vein of Galen malformation) and some relatively unusual lesions in pediatric patients (e.g., pituitary adenoma, meningioma, extrapontine myelinolysis).

**MATERIALS & METHODS**

Cross-sectional imaging of the cases will be displayed along with a brief review of the literature.

**RESULTS**

Some representative cases include: Case 1: 12-year-old male presents with headache, thirst, frequent urination, nausea and vomiting secondary to a large sellar mass with the final pathologic diagnosis of pituitary macroadenoma. Case 2: 14-year-old male presents with obstructive hydrocephalus secondary to a large left parietal-occipital mass with the final pathologic diagnosis of meningioma with atypical features. Case 3: 2-year-old male presents with hydrocephalus secondary to a thrombosed vein of Galen malformation with imaging appearance difficult to differentiate from a solid pineal region neoplasm. Case 4: 2-year-old with diabetes insipidus presents with unusual imaging appearance of extrapontine myelinolysis but with classic clinical manifestations supporting the diagnosis.

**CONCLUSION**

Meningiomas account for less than 5% of intracranial neoplasms in children. Meningiomas in children account for less than 2% of all meningomas in total (1). Childhood meningiomas tend to be larger and more frequently undergo sarcomatous change than those presenting in adulthood. Mutation of the neurofibromatosis (NF) gene is the most likely cause of meningioma in children and at least 20% who initially present with an isolated meningioma eventually are diagnosed with NF2 after other lesions are found (2). Our patient has no other manifestations of NF2 to suggest that he has this condition. Pituitary adenomas comprise less than 2% of all intracranial tumors in childhood. Pituitary tumors are known to more often occur in MEN 1 patients with 10-30% prevalence in the symptomatic MEN 1 population (3). Despite this high prevalence in the general MEN 1 population, these tumors are still considered as rare in the pediatric and adolescent patients with MEN 1 as they are in the general pediatric population (4). Vein of Galen malformation is a well known vascular lesion in children. They usually are diagnosed easily by MRI or ultrasound. However, if the malformation is almost completely thrombosed, as was our case it can be mistaken for a solid pineal region tumor. Extrapontine myelinolysis is a well known osmotic demyelination syndrome; however, our case showed diffusion restriction and FLAIR signal hyperintensity in the subcortical regions diffusely and in the bilateral claustra while sparing the deep gray matter. To our knowledge this presentation is unusual.
REFERENCES

KEY WORDS: Meningioma, pituitary adenoma, extrapontine myelinolysis

Poster 189
Use of 3D T2 Extended Echo Train Acquisitions in the Evaluation of Hydrocephalus

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PURPOSE
The purpose of this study is to evaluate the use of a 3D T2 FSE pulse sequence in the evaluation of cerebrospinal fluid flow. Three-dimensional extended echo train acquisition (XETA) sequences are T2-weighted sequences with readout trains over 100 echoes using refocusing of flip angles. Combining XETA sequences with parallel imaging allows for nearly isotropic submillimeter voxels with whole brain coverage in under 5 minutes.

MATERIALS & METHODS
Fifteen patients referred from neurosurgery clinic for evaluation of hydrocephalus were consented and 3D T2 XETA acquisitions were performed in the sagittal plane. These images then were reformatted into axial and coronal planes. Evaluation of the cerebral aqueduct, foramen of Monro and third ventriculostomy (if present) was performed. These data were compared to traditional cerebrospinal fluid flow studies when available.

RESULTS
Three-dimensional XETA sequences accurately depict the flow of cerebrospinal fluid. In combination with anatomical images this sequence allowed for the detection of cerebrospinal fluid flow through ventriculostomies in most patients. Image demonstrates flow jet through patent third ventriculostomy.

CONCLUSION
Three-dimensional T2 XETA sequences add valuable anatomical information and help support the dynamic cerebrospinal fluid flow studies currently performed in evaluation in hydrocephalus.

KEY WORDS: Hydrocephalus

Poster 190
Identifying MR Imaging Patients at Risk of Nephrogenic Systemic Fibrosis: Initial Experience in a Pediatric Population Using a Combination of Serum Creatine and Evaluation by Kidney Screening Questionnaire

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PURPOSE
To minimize the risk of nephrogenic systemic fibrosis (NSF) we have initiated a kidney screening process for all children scheduled for contrast-enhanced MRI. We present the results of our initial experience.

MATERIALS & METHODS
A kidney screening policy was developed by a multidisciplinary team from Medical Imaging, Kidney Disease, and Pharmacy. When a serum creatinine for eGFR calculation is unavailable, the kidney questionnaire is administered. The questionnaire evaluates 16 risk factors for pediatric kidney disease. A review of the results of such screening from 10/2007 through 5/2008 will be reported. This abstract contains data on the initial 125 patients. It is estimated that by the time of poster presentation data will have been collected on approximately 700 patients.
RESULTS
One hundred twenty-five patients, ages 0-18 years plus 10 adult patients, have been screened for kidney disease to date. Thirty-six of 125 patients had a serum creatinine measurement within the prior 6 months, all having a calculated eGFR greater than 60 ml/min/1.73m². The remaining 90/125 were evaluated using the questionnaire. Twenty-six of 90 patients were flagged as “at risk” by the questionnaire and required serum creatinine and eGFR calculation. Of the 26 “at risk” patients, none had a calculated GFR of less than 60 ml/min/1.73m², and all proceeded to contrast imaging without restriction.

Kidney Risk Factor | Number of positive responses
----- | -----
Prematurity or low birth weight | 5
Referral to kidney specialist or urologist | 4
Family history of renal disease | 2
Dialysis in patient or family member | 3
History of organ transplantation | 0
Liver disease | 0
Chemotherapy or immunosuppressive therapy | 5
Heart disease | 3
Diabetes | 2
High blood pressure | 1
Sickle Cell anemia or thalassemia | 1
Regular NSAID use (at least once/week) | 3
Intravenous iron | 0
Anemia therapy (erythropoietin or darbepoetin) | 0
Diuretic therapy | 1
Statin therapy | 0

CONCLUSION
Seventy-two percent of patients undergoing contrast MRI at a pediatric hospital did not have a recent serum creatinine level. Approximately 29% of patients subsequently screened reported one or more kidney risk factor and required serum creatinine measurement. To date all of the questionnaire-identified “at risk” patients have had eGFR of 60 ml/min/1.73m² or greater.

KEY WORDS: MRI, renal screening, nephrogenic systemic fibrosis

Poster 191
Forebrain Development in Fetal MR Imaging: Detectability before Gestational Week 27

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PURPOSE
Forebrain malformations are one of the most severe developmental anomalies. They often are associated with face dysmorphism and require early diagnosis. Intracranial landmarks of normal forebrain development include cleavage of hemispheres, presence of olfactory structures, the pituitary gland and the corpus callosum. While for example olfactory structures are known to be well depictable from gestational week (gw) 30 onwards (1), data about their morphologic proof in earlier gestational weeks is not yet available. The purpose of this retrospective study was to evaluate the detectability of anatomical landmarks of forebrain development with in vivo fetal MRI before gw 27.

MATERIALS & METHODS
MRI studies of 83 fetuses (gw 16-26, average ± std: 22 ± 2) performed with a 1.5 T magnet were assessed. T2-weighted fast spin-echo sequences, T1-weighted gradient-echo and diffusion-weighted sequences were screened for the detectability of anatomical landmarks as listed below. Statistical analysis was performed using SPSS (11.5.1 SPSS Inc., Chicago, Ill).

RESULTS
The interhemispheric division, corpus callosum, infundibulum, chiasm, septum pellucidum, profile and palate were detectable in 95/89/87/82/79/78/78% of cases. Olfactory tracts were delineated more easily than bulbs and sulci (37% versus 14 and 18% respectively). Coronal T2-weighted sequences were the most sensitive ones. The pituitary gland could be detected on T1-weighted images in 60% of cases, with a significant increase of diameter with gestational age (p = 0.041). The delineation of olfactory tracts, chiasma, septum pellucidum and pituitary gland were significantly increased after week 21 (p < 0.05). Pathologies were found in 28% of cases.

CONCLUSION
For evaluation of forebrain development, anatomical landmarks like the interhemispheric division, corpus callosum, septum pellucidum and chiasma are readily detectable in early fetal MRI. Identification of olfactory structures requires a coronal T2-weighted sequence and is possible in about one third of cases between gw 16 and 26.

Figures: a) Coronal T1-weighted MR image showing hyper-intense pituitary gland (gw 21); b) Coronal diffusion-weighted MR image demonstrating the corpus callosum (gw 22); c) Coronal T2-weighted MR image with the olfactory tracts (gw 24); d) Sagittal T2-weighted MR image demonstrating the fetal profile (gw 23).
REFERENCES

KEY WORDS: Fetal MRI, forebrain, development

Poster 192
Leukomalacia Periventricular by 3 T MR Imaging and Transfontanelar Ultrasound: Case Report

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PURPOSE
Periventricular leukomalacia (PVL) is a disease of premature or newborn infants hypoxic and ischemic leading to infarction of brain white matter and ventricle enlargement. The purpose is to demonstrate the radiologic features by 3 T MRI and transfontanelar ultrasound in a PVL case.

MATERIALS & METHODS
Case report: A preterm newborn infant of 31 weeks of gestational age, delivered by cesarean section secondary to fetal distress and polyhydramnios, was diagnosed with meconium aspiration that required artificial ventilation at birth (Apgar 6-8). The metabolic screening and C reactive protein were normal. A STORCH test was negative. The transfontanelar portable ultrasound (Sonosite 180 plus) and MRI (GE Signa Excite II 3.0T) performed using T1 (10.1/1450 TI920), T2 (110.7/3300), FLAIR (121.1/8002 TI:2200) and Diffusion (100.2/8325, b=1000) sequences reported PVL.

RESULTS
Periventricular leukomalacia is one of the most common ischemic brain injuries in premature infants. The role of ultrasound is known by diagnosing PVL and using additional MRI improves their characterization. Periventricular leukomalacia is the second most frequent lesion of the infant brain, following hemorrhage into the germinal matrix or ventricle and a significant percentage of surviving premature infants with this pathology develop functional neurologic deficit.

CONCLUSION
The sonographic characteristics in PVL are better appreciated by MRI, becoming the proper imaging method providing essential anatomical and structural information required to manage and also to evaluate the extension of cerebral damage.

KEY WORDS: Leukomalacia, MRI, ultrasound

Poster 193
Neonatal Intracranial Hemorrhage: One Year Follow Up Shows Increased Brain Size (Preliminary Data)

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PURPOSE
In a previous study, three of the authors found that the prevalence of intracranial hemorrhage (ICH) in vaginally delivered neonates is 26%. It is unclear, though, whether neonatal ICH has any effect on brain growth and development. The purpose of this study is to follow the cohort of babies with ICH in the previous study to 1 year of age and determine if development has been altered. Particular attention was placed on the cerebellum as it grows considerably in the first year of life and ICH was observed most commonly in the posterior fossa. We hypothesize that there will be no differences in brain size between babies with neonatal ICH and those without.

MATERIALS & METHODS
Subjects and Imaging: Pregnant women were recruited for a prospective HIPAA-compliant study of neonatal brain development. After parental informed consent, neonates were imaged with 3.0 T MR imaging without sedation. The babies in the study were followed and invited for identical follow-up scans at 1 year of age. Analysis: Of the babies identified with neonatal ICH in the previous study, nine (7 male, 2 female) underwent 1-year scans (ICH group). Each was matched to one control for gender, gestational age at birth, gestational age at MRI, maternal age, race, maternal education, and prenatal ventricular size (Control group). For both groups, neonatal and 1-year scans were segmented by brain region for gray and white matter. The variables analyzed at both time points were brain tissue volume (BV), total gray matter (GM), total white matter (WM), and cerebellar volume (CV). These measures were compared between the ICH and control groups at neonatal and 1-year scans.

RESULTS
Preliminary results show proportionately higher 1-year BV, GM, WM, and CV in the ICH group compared to the control group at 1 year, but equal or decreased volumes at neonatal scan (Table). Statistical analysis does not yield significance due to low power.

Table: Brain Volumes of ICH and Controls at Neonatal and 1-Year Scans

<table>
<thead>
<tr>
<th>Scan</th>
<th>Volume</th>
<th>ICH Group Mean Volume (cm³) (Standard Deviation)</th>
<th>Control Group Mean Volume (cm³) (Standard Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BV</td>
<td>407 (48)</td>
<td>421 (44)</td>
<td></td>
</tr>
<tr>
<td>GM</td>
<td>237 (29)</td>
<td>250 (27)</td>
<td></td>
</tr>
<tr>
<td>WM</td>
<td>170 (21)</td>
<td>175 (19)</td>
<td></td>
</tr>
<tr>
<td>CV</td>
<td>27 (2)</td>
<td>27 (2)</td>
<td></td>
</tr>
<tr>
<td>BV</td>
<td>897 (94)</td>
<td>816 (107)</td>
<td></td>
</tr>
<tr>
<td>GM</td>
<td>631 (67)</td>
<td>599 (77)</td>
<td></td>
</tr>
<tr>
<td>WM</td>
<td>266 (45)</td>
<td>217 (31)</td>
<td></td>
</tr>
<tr>
<td>CV</td>
<td>94 (11)</td>
<td>86 (12)</td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION
We observed trends showing increased brain size at 1 year in babies with neonatal ICH. Due to the small sample size, however, the trends did not reach statistical significance. The proportional increase in brain size between the neonatal and
1-year scans implies that neonatal ICH does not cause lasting damage which inhibits brain growth. This was true as well regarding the cerebellum, near the ICH site in most cases. The reason for a size increase that is greater in the ICH group as compared to the controls is unclear. This study was limited by the small number of subjects and controls, and as more subjects from the previous study obtain 1-year scans, statistical power should improve.

**Key Words:** Intracranial hemorrhage

**Poster 194**

**Basal Ganglia Abnormalities in Children Affected by Methylmalonic and Propionic Acidemias Treated with Liver Transplantation**

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**Purpose**

Methylmalonic and propionic acidemias are rare metabolic disorders, presenting generally during childhood with neurologic symptoms. Basal ganglia lesions are documented on MR examination. Effective treatments have not been established so far; liver transplantation has recently been proposed. We present the MR findings in 4 patients (2 cases of methylmalonic acidemia and 2 cases of propionic acidemia), aging between 3 and 14 years (mean age 7.7 years) treated with liver transplantation.

**Materials and Methods**

MR studies were performed before and after surgical procedures (follow up after surgery: 17-33 months).

**Results**

All patients showed normal findings at first examination, before treatment. Signal changes in the basal ganglia were documented in the follow-up period after metabolic crises and involved both striatum and pallidus bilaterally in 3 patients (2 with propionic and 1 with methylmalonic acidemia) and pallidi in 1 case of methylmalonic acidemia. In all patients the abnormalities were present as high signal also on T1 weighted images (fig.1)

![Fig. 1](image)

**Conclusion**

Our results differ partially from the MR features reported in the literature as typical for these conditions. Patients with methylmalonic acidemia show T2-hyperintensity in the globus pallidum, while propionic academia is characterized by long T2 in the striatum. Hyperintensity on T1 is not reported. The reason for this discrepancy is not clear; one possible explanation is that liver transplantation may prevent minor encephalopathic crises but not major episodes of metabolic failure which seem to be multiorgan and could produce more diffuse damage.

**Key Words:** basal ganglia, acidemia, liver transplantation

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**Poster 195**

**Double Reading of Neuroradiologic MR: Experience and Results of an 18-Month Study**

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**Purpose**

To share our double reading (DR) experience with neuroradiology MR reports. Telemedicine Clinic provides a teleradiology service for public and private hospitals throughout Europe. Radiologists from several European countries report on radiologic investigations. The aim of DR is to achieve the highest level of diagnostic accuracy and to reduce the incidence of diagnostic errors, by using the combined professional expertise of two radiologists.

**Materials & Methods**

DR has been performed in 100% of the cases. We have done a retrospective review of neuroradiologic DR performed by 11 experienced neuroradiologists, from January 1, 2006 to June 30, 2007. The final report was done following our grading guidelines. We have devised a grading system that allows us to define disagreements between the two radiologists as follows: Grade 0: full agreement; Grade 1: minor disagreement: changes made, no potential clinical consequences; Grade 2: moderate disagreement: changes made unlikely to have significant clinical consequences; Grade 3: significant disagreement: changes made, potential for clinically significant consequences and Grade 4: different interpretation by both radiologists: high potential for clinically significant consequences. For Grade 0, the report written by the first reader was issued. For Grade 1, the report with the changes introduced by the second reader was considered as definitive. In the case of grades 2 to 4, the changes were communicated to the first reader for discussion, and to give him/her the opportunity to agree or disagree. When no consensus was achieved, the Section Leaders decided the final diagnosis. Included in the DR protocol was the Language Quality Control, whereby all reports can be edited, when necessary, by a qualified English Language Quality Control team. This
ensures that the reports contain the highest standard of written English and conform to British medical terminology standards. DR has been used to evaluate the professional level, expertise and radiologic language skills of new radiologists before their official commitment with TMC begins. It is used also as a training and teaching method, as well as one of the assessment measures of our internal Quality Control protocols.

**RESULTS**

Out of a total of 36290 neuroradiologic reports most disagreements were of no clinical consequence (Grade 0: 62,10; Grade 1: 26,92%; Grade 2: 7,69%). Clinically important disagreements were about 3% (Grade 3: 3,01%; Grade 4: 0,27%). Most of the nonsubspecialist radiologists have shown significant quality improvements on our internal audits. Moreover, specialists in training and those with different commitments to TMC, have all been given an objective assessment of their performance in terms of the quality of their reports. We categorize errors under 3 separate headings: (A) hypo-concentration errors (“slip-mistakes”), (B) radiologist ‘expertise-dependent’ errors (misinterpretation) and (C) oversight omissions.

**CONCLUSION**

A systematic and controlled DR approach assures high quality reports. Diagnostic errors and slip mistakes are lowered, though most of the discrepancies found were due to different reporting styles and structures. This highlights the importance of a unified reporting style for better communication both between the radiologists, and with the referring physicians.

**KEY WORDS:** Quality control, teleradiology, audits

**Poster 196**

**Quality Control of Teleradiology Reporting**

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**PURPOSE**

To share our experience, and our protocols used to ensure the quality of radiologic reporting by means of teleradiology.

**MATERIALS & METHODS**

The quality control protocol involves each of the following steps: A. Monthly internal and external audits of the reports. B. Double reading of the radiologic examinations using a protocol for managing discrepancies between readers. C. Improved communication between TMC and the hospitals by means of clinical sessions, telephone consultations and email communication. D. Assessment of the professional level of the radiologists: before starting their contract by evaluating their reports, at the beginning of their work by progressively assigning them more cases depending on the number/percentage of disagreements found on double reading, and finally, giving them the results of the quality control evaluation of their work and by promoting continuous training and development.

**RESULTS**

A. Of the 11,548 neuroradiology examinations reviewed, 230 (2%) were audited in TMC, and 115 (1%) were externally audited. B. Double reading was performed on all the examinations reported. C. The NR section collaborated in five clinical sessions per week: two via video-conference, two in TMC and one in person in the hospital. We replied to 38 clinical queries/consultations, either by email or by telephone. D. The reports of 10 radiologists undergoing the process of becoming contracted to TMC were evaluated, and follow up was made of seven of the 48 radiologists in the neuroradiology section, due to a high percentage of discrepancies in their reports.

**CONCLUSION**

Quality control protocols enable objective evaluation and guaranteed quality of radiologic reporting in a radiology service. This is even more the case in teleradiology in an international, multilingual and heterogeneous environment.

**KEY WORDS:** Quality control, teleradiology, audits

**Poster 197**

**Provocation Lumbar Diskography at Previously Fused Lumbar Levels**

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**PURPOSE**

To assess the provocation diskogram results and clinical value of performing provocation lumbar diskography at previously fused lumbar levels.

**MATERIALS & METHODS**

Over a 3-year period, 29 patients with prior lumbar fusion were identified who underwent provocative diskography and these cases were reviewed retrospectively. In 20 patients, residual pain similar to their previously treated back pain persisted and diskography included testing of the previously fused levels. In nine patients, only levels adjacent to the previous lumbar fusion were studied. Twenty-four postfusion levels were studied in the 20 patients. Diskography results were evaluated and follow up assessed including subsequent surgical revision.

**RESULTS**

Twelve of 24 (50%) previously fused levels demonstrated a positive and concordant pain response at diskography. Of the remaining 12 previously fused levels, nine were negative and three demonstrated nonconcordant pain. Adjacent level concordant pain was demonstrated also in nine total patients - three in patients with positive concordant fused levels, four
in patients with negative fused levels, and two in patients with nonconcordant fused levels. Surgical revision was performed at the previously fused level in six patients, all of which had demonstrated concordant pain during diskography. In three of these patients, additional interbody fusion also was performed at an adjacent disk level. Four fused levels demonstrated diskographic contrast leakage. Interbody fusion also was performed at an adjacent level in two patients with negative response at the previously fused level. Overall, surgical revision was performed in eight patients, of which six had concordant fusion level pain. The two patients without concordant fusion level pain had surgery at adjacent levels only.

**CONCLUSION**

Pain can be identified by provocation lumbar diskography at previously fused lumbar levels and these are commonly surgically revised. Adjacent level provoked pain is not uncommon, and these levels also may undergo a primary operation or be included in a surgical revision.

**KEY WORDS:** Diskography, spine, intervention

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**Poster 198**

**Normal and Abnormal Imaging Findings in Lumbar Total Disk Replacement: A Review of the Devices and the Complications in Total Disk Replacement**

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The traditional treatment of symptomatic lumbar degenerative disk disease that has failed conservative management has been arthrodesis with or without diskectomy. Even in the setting of a solid arthrodesis there still may be significant long-term problems, including recurrent low back pain, spinal stenosis, hypertrophic facet disease, pseudoarthrosis, or spondylolysis and spondylolisthesis at the adjacent levels. Additionally, several studies have shown a relationship between solid fusion and the development of adjacent level disk disease, thought to result from increased stress or hypermobility of the adjacent segment. Total disk replacement (TDR) was developed as a means of restoring normal mobility of the diseased segments, theoretically improving clinical outcomes by decreasing the risk of adjacent level degenerative disease and other related complications. Total disk replacement, like arthrodesis, is not without complications. While some complications, such as migration and subsidence, are seen in the device category as a whole, several are device-specific complications, such as extrusion of polyethylene inlay and vertical fractures, for which detailed knowledge of the individual devices is important. Facet arthrosis, device wear and particle disease, adjacent level degeneration, and heterotopic ossification also have been seen in TDR, but the frequency and significance remain uncertain. Given the increasing prevalence of lumbar total disk replacement, it is imperative that the radiologist be familiar with the more commonly used devices and the potential complications of their use.

**KEY WORDS:** Total, disk, replacement
Osteoporotic Vertebral Compression Fractures: Imaging Correlates with Baseline Pain and Functional Status

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PURPOSE
To determine the association between baseline imaging findings in patients with osteoporotic vertebral compression fractures and measures of pain and functional status.

MATERIALS & METHODS
This study reports baseline data from of an ongoing, multicenter randomized clinical trial evaluating the safety and effectiveness of percutaneous vertebroplasty in the treatment of osteoporotic vertebral compression fractures. We evaluated MR and CT images for bone marrow edema (none, possible, definite/focal and definite/diffuse), percent vertebral body height loss, fracture type, intravertebral CSF cleft, presence of vertebral plana, degenerative disease, and central stenosis. All subjects had at least one painful osteoporotic vertebral compression fracture (T4 to L5) that occurred in the previous 12 months. Exclusion criteria included malignant fracture, concomitant hip fracture, or recent surgery. Baseline questionnaires included a numerical pain scale (0-10) and the modified Roland scale, a well-validated measure of back pain disability. We hypothesize that patients with greater number of fractures and more extensive bone marrow edema will have worse baseline pain and functional status.

RESULTS
To date, we have analyzed the imaging of 25 subjects and anticipate 100 subjects by May 2008. The mean subject age was 71 years (range 50-86 years), and 68% were female. The mean pain rating at baseline measured 6.7 (standard deviation (SD) = 2.2). The mean Roland score at baseline was 17.2 (SD = 4.3). Univariate analysis showed a borderline significant association between the degree of marrow edema and development of symptoms in patients with low back pain without apparent disk herniation. The aim of this study was to evaluate annular tear of intervertebral disk using axial T2 mapping, with a special focus on low back pain without apparent disk herniation.

CONCLUSION
Our results are concordant with previously published results (1-3). While marrow edema appears to be related to painful fractures, we could not show a similar relationship with disability. As we analyze more subjects, other relationships between imaging and clinical aspects of fractures may become apparent.

REFERENCES
2. Ito H, Matsuno T, Minami A. Relationship between bone marrow edema and development of symptoms in patients with osteonecrosis of the femoral head. AJR Am J Roentgenol 2006;186;1761-1770

KEY WORDS: Fracture, edema, pain

Evaluation of Annular Tear of Intervertebral Disk with Axial T2 Mapping

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PURPOSE
Magnetic resonance (MR) imaging is useful to evaluate degeneration of intervertebral disks. MR imaging in the sagittal plane may make it possible to assess different levels of degeneration of intervertebral disks and adjacent structures such as end plates, vertebral bodies, and bone spurs at one time; however, the sagittal plane limits the area of degeneration of intervertebral disks in the field of view more than the use of axial slices. Transverse relaxation time (T2) mapping has the potential to quantitatively evaluate deterioration of intervertebral disks. T2 is sensitive to water content and arrangement of collagen network structure and also is influenced by the dipolar interaction due to anisotropic motion of water molecules in the collagen matrix. T2 mapping can be an ideal quantitative marker of degeneration intervertebral disks in patients with low back pain without apparent disk herniation. The aim of this study was to evaluate annular tear of intervertebral disk using axial T2 mapping, with a special focus on low back pain without apparent disk herniation.

MATERIALS & METHODS
Ten patients were studied, and axial T2 mapping was performed at the one level of intervertebral disks decided by clinical symptoms and conventional sagittal images on 1.5 T system (Sigma, GE Medical Systems). Sagittal T1- and T2-weighted imaging of the whole lumbar spine was performed prior to T2 mapping to look for possible pathologic changes such as degenerative disk, spondylolysis, spinal canal stenosis, scoliosis, and facet osteoarthritis, as well as to select an axial-plane slice passing through the center of the disk. T2 measurement with single-slice acquisition was performed at the selected slice by a set of morphologic images. A multispin-echo sequence was used for T2 measurement because it allows for acquisition of T2 values within a suitable acquisition time. The multispin-echo scanning parameters were 1500 msec TR, 10 TEs of 10.3-103 msec, 150 ~150 mm field of view, 4.0-mm slice thickness, 320 ~320 matrix, and 1 excitation. Total scan time for this sequence was 8 minutes 21 seconds per disk. T2-calculated maps were generated using MATLAB software (Mathworks, Natick, MA) with mono-exponential curve fit. Immediately after that, reproducibility of low back pain with local injection of iodized contrast material was tested under fluoroscopy and CT diskography was performed.
In all patients, reproducibility of low back pain was demonstrated by injection of contrast material. The mean amount of the contrast material was 0.87 ± 0.6 ml. Findings of T2 maps were well correlated with grade of annular tear depicted with CT diskograms.

**CONCLUSION**

Axial T2 mapping provides a more T2-based demonstration of annulus fibrosus of intervertebral disk. It cannot evaluate noninvasively early degenerative changes of annular tear.

**KEY WORDS:** T2 mapping, annular tear, intervertebral disk

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**Poster 201**

**Is MDCT of the Spine an Acceptable Alternative to MR in Suspected Acute Spinal Cord Compression?**

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**PURPOSE**

MR has become accepted as an essential examination for patients presenting with signs of acute cord/cauda equina compression but is not always routinely available at all times without neurosurgical centers in Europe. MR may not be performed in patients with MR contraindications and study quality is often suboptimal in the emergency situation due to patient movement or claustrophobia. MDCT is ubiquitous and can provide excellent spinal imaging at reasonable radiation doses and lower cost than MR. Could it be safely in place of MR to avoid delays in diagnosis and treatment?

**MATERIALS & METHODS**

The anonymous imaging of 33 consecutive adults referred to the Institute of Neurosciences, Glasgow, UK, with possible nontraumatic cord/cauda equina compression who had contemporaneous MR and MDCT was transferred onto DVD and reanalyzed. The studies were read in a random order to prevent cross-referencing of MDCT and MRI. A detailed questionnaire was completed for each examination by 2 readers. The first author recorded the final pathology and correlated findings.

**RESULTS**

There was excellent correlation between MDCT, MRI, the presence of spinal pathology and final pathology. Extraspinal relevant abnormalities were shown more commonly with MDCT. Both modalities had limitations. An appropriate MDCT technique is postulated for use in referring hospitals.

**CONCLUSION**

For neuroradiologists MDCT is an accurate alternative to MR in assessing acute spinal compression. This study now will be extended to include general radiologists to determine if the results are valid for general radiologists.

**KEY WORDS:** Spinal cord compression, MDCT, diagnosis

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**Poster 202**

**Imaging of the Spine: Unusual Lesions within the Classic Compartments**

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**PURPOSE**

To report a pictorial review of uncommon lesions occurring within the classic spinal compartments, intramedullary, intradural-extradural, and extradural.

**MATERIALS & METHODS**

The imaging, neuropathology and clinical records of six patients with unusual spinal lesions from September 2005 to November 2007 were reviewed. A literature search was performed for each of the lesion types presented. The results, including significant images from CT and MRI examinations as well as discussion of the lesions are presented in a pictorial review.

**RESULTS**

In all patients presented, the final pathologic diagnosis was different from what was suspected initially by imaging and clinical information alone. In most cases, the spinal compartment was correctly identified, but in no case was the actual pathologic diagnosis clear prior to surgical confirmation. Representative cases for each of the three classic compartments include synovial sarcoma, plasma cell tumor, Ewing’s sarcoma, and paraganglioma.

**CONCLUSION**

In the neuroimaging of spinal lesions, the differential diagnostic considerations usually are straightforward, determined primarily by the location in relation to the spinal cord and dura, as well as the age of the patient. Although the most common diagnoses will account for the vast majority of lesions encountered, it is important to be aware of less common entities that may occur within each of the three classic compartments. Such cases present a challenge to the radiologist when forming differential diagnoses.

**REFERENCES**


**KEY WORDS:** Spine, spinal cord, unusual tumors
Usefulness of Isotropic Single-Slab 3D Turbo Spin-Echo Images Compared with Fast Spin-Echo T2-Weighted Images in Lumbar Spine

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PURPOSE
The purpose of this study is to evaluate the usefulness of isotropic single-slab 3D Turbo Spin-Echo (SPACE: Sampling Perfection with Application-optimized Contrasts using difference flip angle Evolutions) sequence compared with the fast spin echo (FSE) T2-weighted sequence for the evaluation of lumbar spine pathology.

MATERIAL & METHODS
We obtained both FSE T2-weighted and SPACE sagittal L-spine MR images in consecutive 26 patients simultaneously. The mean patient age was 54.4 years old (range: 19-71, 18 female and 8 male). All MR imaging was performed on a 1.5 T MR unit (Magnetom Avanto; 1.5 T System, Siemens Medical Solution, Germany) using a spine array coil along with a body coil. The image acquisition time was approximately 4 minutes in each image sequences. All MR images were reviewed independently and qualitatively analyzed by two musculoskeletal radiologists. The contrast-to-noise ratio (CNR), the signal-to-noise ratio (SNR) of nerve root vs per -

RESULTS
The diagnostic quality of the SPACE images was superior to that of the FSEI T2-weighted images in both observers (p < 0.05). The mean value of CNR and SNR was not statically significant (p > 0.05). In the assessment of the CNR, SNR, and diagnostic quality, the k values poor to fair agreement ranged from -0.054 (p = 0.88) to 0.354 (p = 0.69), and the Kappa values were very low despite the relatively high overall agreement in both images due to the concentrated distribution of the agreement, which is referred to as the Kappa paradox.

CONCLUSION
SPACE images were superior in diagnostic quality as compared with FSE T2-weighted images, and statistically not significant in CNR and SNR. Therefore, SPACE images can replace FSE T2-weighted images and furthermore, the capability of 2D reformatted multiplane images in SPACE is unique and is not comparable to FSE T2-weighted images.

KEY WORDS: Lumbar spine, pulse sequence, 3D
CONCLUSION
This data suggests that performance of an ILESI at the lumbar intervertebral level of maximal stenosis is more effective in short-term pain and disability reduction than performance of the ILESI at a less pathologic intervertebral level, with no increased risk for immediate postinjection pain exacerbation. To maximize patient benefit, ILESIs should be fluoroscopically guided to ensure performance at the intervertebral level of maximal stenosis.

KEY WORDS: Spinal stenosis, epidural, steroid

Poster 205
Percutaneous Vertebroplasty for Painful Compression Fractures in a Small Cohort of Patients with Decreased Expectation-Related Placebo Response Due to Dementia

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PURPOSE
Vertebroplasty has been studied in multiple retrospective and observational studies as well as in a handful of controlled trials. None of these prior studies has included a placebo group, however, so the impact of the placebo effect on vertebroplasty outcomes remains unknown. Patients suffering with dementia have been shown to be less susceptible than other patient groups to the expectation-related placebo effect (1). We hypothesized that study of vertebroplasty outcomes in patients with dementia would offer insight into the impact of the placebo effect on improvement in pain and mobility following this procedure.

MATERIALS & METHODS
After obtaining institutional review board approval, all patients with clinical and objective evidence of dementia who had undergone vertebroplasty at our institution were identified from a comprehensive, prospectively constructed vertebroplasty data base. Outcomes of the entire vertebroplasty cohort contained in this data base have been published previously without specific analysis of patients with dementia (2). Pain at rest and with activity were analyzed at 2 hours, 1 week, 1 month, 6 months, and 1 year postoperatively. Mobility and medication use were recorded at 1 week, 1 month, 6 months, and 1 year. Responses to outcomes questions were made by the patient or by a family member or other caretaker. Because patients with dementia usually were unable to offer numerical pain ratings, we instead documented pain outcomes as completely resolved, improved, unchanged, or worse compared to prevertebroplasty states. Mobility was recorded as increased, unchanged, or decreased. Opiate and/or nonopiate pain medication use was recorded as medication-free, decreased, unchanged, or increased.

RESULTS
Ten patients met strict inclusion criteria. Three patients died during the follow-up time period. Between 40 and 90% of patients were contacted successfully at any given time period. Pain both with activity and at rest decreased or resolved in 80-100% of patients at each time point. Mobility increased in 80-100% of patients at all time points compared to preprocedural mobility. Pain medication was decreased or stopped in 67% of patients at 1 week and in 100% of patients at 6 months and 1 year.

CONCLUSION
Treatment of painful compression fractures with vertebroplasty in patients with dementia is associated with considerable reduction in pain and improvement in mobility. Although definitive characterization of the true efficacy of vertebroplasty will require completion of a placebo-controlled trial, this study offers evidence that the benefits of vertebroplasty may be independent of placebo effect.

REFERENCES

KEY WORDS: Vertebroplasty, placebo, dementia

Poster 206
Kyphoplasty in Patients with Spinal Canal Compromise

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PURPOSE
Although retropulsion of a fracture fragment causing significant spinal canal compromise usually is regarded as a relative contraindication to percutaneous vertebral augmentation, in 2004, Appel and Gilula reported 23 cases in which vertebroplasty was performed at levels showing effacement of the epidural space, in patients without radicular signs. They also devised a classification based on MRI appearance. At our institution, kyphoplasty and CT scans customarily are performed. Our results, gathered in such patients, are reported here. We prefer reformatted thin-section CT scans because of better depiction of osseous structures. As a consequence, we use a modified classification where category 0 represents normal spinal canal, category 1 loss of ventral epidural space with no spinal cord deformity and category 2 also spinal cord deformity. As cortical bone usually is violated, technique is modified in order to cover defects by repeated injections of small amounts of dough-like cement before filling up the bone cavity. In keeping with data recently reported by Greene and coworkers, we feel that the inflatable balloon tamp is helpful in performing such a task. This is the main reason why we favor kyphoplasty over vertebroplasty.

MATERIALS & METHODS
From September 2005 to October 2007, 11 hospitalized patients (age: 22-92 years; M: 6, F: 5) underwent kyphoplasty because of a nonsurgical vertebral fracture with spinal canal compromise, involving the spine from D11 through L4. Specifically, five cases were classified as category 1 and six as category 2. Preoperatively, a CT scan was performed and radiographs obtained to assess vertebral deformity,
while clinical data were supplemented by Visual Analog Scale (VAS) pain rating. All of the aforementioned were repeated after kyphoplasty. Follow-up evaluations were scheduled at 1, 3, 6, 12 and 24 months.

**RESULTS**

Early mobilization (on the second postop day) was obtained in all patients, as well as pain relief (baseline VAS score: 8.6 95% CI 7.7-9.4; 48 hours postop: 1.6 95% CI 0.5-2.8). Radiographic improvement was only slight or moderate. In 2 subjects, limited amounts of cement leakage were noted. No clinical complications occurred.

**CONCLUSION**

Percutaneous vertebral augmentation has grown in acceptance and is becoming the standard of care for pain associated with compression fractures of the spine. Our data are in agreement with those previously reported that both vertebroplasty and kyphoplasty can produce immediate improvement in a patient’s quality of life. As it already has been pointed out, spinal canal compromise and even spinal cord compression, in themselves, should not preclude performance of vertebroplasty and kyphoplasty can produce immediate improvement in a patient’s quality of life. As it already has been pointed out, spinal canal compromise and even spinal cord compression, in themselves, should not preclude performance of vertebroplasty. However, within 24 hours following the vertebroplasty he suffered new-onset pain similar to that prior to the procedure. He underwent repeat T6 vertebroplasty, which filled a prominent fracture line under the superior endplate. His pain relief was incomplete, but was improved compared to the severity of the recurrent pain episode.

**RESULTS**

Both of our patients had thoracic compression fractures with prominent inferior subendplate clefts which were targeted selectively with cement for treatment. In both patients, there was limited filling of the trabecular portion of the vertebral body outside of the cleft. While both patients had excellent acute pain relief, both suffered early, new painful fractures with marrow edema at the treated level. Both patients were retreated with a second vertebroplasty at the same level with attention to more homogeneous filling of the adjacent trabecular portion of the vertebral body. Both patients had at least some response after retreatment and have not developed further compression.

**CONCLUSION**

While isolated filling of subendplate clefts can give excellent symptomatic relief for the treatment of compression fractures, we suggest that this may predispose patients for refracture of the same vertebral level in the subacute setting. When possible, in the setting of subendplate clefts, we recommend filling of both the intravertebral subendplate cleft, as well as the more central trabecular portion of the vertebral body in an effort to reduce refracture risk.

**KEY WORDS**: Kyphoplasty, spinal fractures, spinal canal

**Poster 207**

**Fill the Crack, Break Your Mother’s Back?**

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**PURPOSE**

Preexisting, intravertebral clefts commonly are seen prior to vertebroplasty and many practitioners routinely target these clefts for cement infusion. We report two cases in which targeted cleft filling resulted in new, painful fractures within the treated vertebrae within 24 hours. These cases raise the question as to how cleft-bearing vertebrae should be treated with vertebroplasty.

**MATERIALS & METHODS**

Case 1: A 77-year-old female with osteoporosis secondary to chronic steroids and prior vertebroplasty at L1 and L5 presented with an acute compression fracture of T10. MRI demonstrated compression of T10 with a prominent inferior subendplate cleft and surrounding marrow edema. Using a unipedicular approach at T10, the cleft was targeted and filled with cement. No significant filling of the vertebral body was performed due to concerns about cement extravasation. Pain relief was complete and immediate. However, approximately 24 hours following the vertebroplasty, as she was mobilizing for discharge, she suffered new-onset, excruciating pain, similar in character and location to that suffered prior to vertebroplasty. MRI showed extension of edema within the treated T10 vertebral body. Repeat vertebroplasty with filling of the central aspect of the T10 vertebral body provided excellent pain relief. Case 2: A 78-year-old male with osteoporosis secondary to chronic steroid use presented with an acute compression fracture of T6 with a prominent inferior subendplate cleft. Using a unipedicular approach at T6, targeted filling of this cleft was achieved. There was minimal extravasation of cement into the prevertebral soft tissues after this cleft was filled. As a result, no further cement was injected, leaving the central vertebral body largely unfilled. Despite this, the patient had an excellent clinical response. However, within 24 hours following the vertebroplasty he suffered new-onset pain similar to that prior to the procedure. He underwent repeat T6 vertebroplasty, which filled a prominent fracture line under the superior endplate. His pain relief was incomplete, but was improved compared to the severity of the recurrent pain episode.

**RESULTS**

Both of our patients had thoracic compression fractures with prominent inferior subendplate clefts which were targeted selectively with cement for treatment. In both patients, there was limited filling of the trabecular portion of the vertebral body outside of the cleft. While both patients had excellent acute pain relief, both suffered early, new painful fractures with marrow edema at the treated level. Both patients were retreated with a second vertebroplasty at the same level with attention to more homogeneous filling of the adjacent trabecular portion of the vertebral body. Both patients had at least some response after retreatment and have not developed further compression.

**CONCLUSION**

While isolated filling of subendplate clefts can give excellent symptomatic relief for the treatment of compression fractures, we suggest that this may predispose patients for refracture of the same vertebral level in the subacute setting. When possible, in the setting of subendplate clefts, we recommend filling of both the intravertebral subendplate cleft, as well as the more central trabecular portion of the vertebral body in an effort to reduce refracture risk.

**KEY WORDS**: Vertebroplasty, intravertebral clefts, compression fracture

**REFERENCES**


**KEY WORDS**: Kyphoplasty, spinal fractures, spinal canal
Poster 208
Balloon Kyphoplasty for the Treatment of Pathologic Vertebral Compressive Fractures
Runge, M. · Godard, J. · Wendling, D.
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Besancon, FRANCE

PURPOSE
To evaluate the clinical and radiographic efficacy of balloon kyphoplasty in the treatment of vertebral body compression fractures caused by osteoporosis, myeloma, osteolytic metastasis and hemangioma.

MATERIALS & METHODS
Eighty-three vertebral compression fractures were treated with balloon kyphoplasty in 80 consecutive patients. Symptomatic levels were identified by clinical examination, CT scan and MRI. During the follow up, visual analog score was documented and CT or MRI were performed. Vertebral body height and kyphotic deformity were measured by comparing preoperative and postoperative radiographic measurements.

RESULTS
The pain score decreased significantly in all patients from pre to posttreatment with reduction (21.1%) or stopping (72.9%) of analgesic drugs. The radiologic follow up was documented and CT or MRI were performed. Vertebral body height and kyphotic deformity were measured by comparing preoperative and postoperative radiographic measurements.

CONCLUSION
Balloon kyphoplasty safely improves vertebral body height and patient quality of live. The prevalence of a new vertebral fracture in the adjacent level is low.

KEY WORDS: Kyphoplasty, vertebral compression fracture

Poster 209
Resident and Teleradiologist Evaluation of Emergency Cervical Spine CT Scans
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PURPOSE
Prior studies have reported that the level of resident training has an effect on the rate of disagreement between preliminary interpretations of CT scans and the final interpretation by neuroradiologists. At our institution, CT scans of the cervical spine performed after the regular hours of operation are interpreted by a radiology resident and “overread” by an off-site teleradiology attending. The purpose of this study was to assess the performance of junior and senior radiology residents in the interpretation of emergency cervical spine CT scans with the benefit of an additional interpretation “overread” by the teleradiology attending.

MATERIALS & METHODS
Retrospective evaluation was performed of 229 consecutive emergency cervical spine CT studies that had been interpreted by first- or third-year radiology residents and “overread” by a teleradiologist. Discrepancies between these combined preliminary interpretations and the final interpretations made by staff neuroradiologists (all with a Certificate of Added Qualification) were classified as “disagree-minor” or “disagree-major.” Major discrepancies were those that had the potential to increase patient morbidity, extend hospital stay, or change treatment.

RESULTS
Overall, the agreement rate of the combined preliminary interpretations of the senior residents/teleradiologists and the final neuroradiologist interpretation was 92%; the rate of minor discrepancies was 2.4%; the rate of major discrepancies was 5.6%. The agreement rate for junior residents/teleradiologists was 92.3%; the rate of minor discrepancies was 4.8%; the rate of major discrepancies was 2.9%. The level of training had no significant effect on the rate of agreement (P = 0.88). Major discrepancies included missed epidural hematoma, fracture, disk protrusions, and false positive fractures. Minor discrepancies included missed chronic fractures and lymphadenopathy. The teleradiologist made “overreads” in 4.0% of the cases interpreted by senior residents and 4.8% of the cases interpreted by junior residents. These cases were not considered minor or major discrepancies, as the findings were reflected in the combined preliminary interpretation. Changes included pulmonary infiltrate, dystrophic thyroid calcification, and lung nodule. A perched facet also was described by the teleradiologist in the setting of a previously described acute fracture.

CONCLUSION
When an additional interpretation is provided by a teleradiologist, the level of resident training has no significant effect on the rate of disagreement between the preliminary reports of emergency cervical CT scans by residents and the final neuroradiologist interpretation. Additionally, differences between the resident read and teleradiologist read usually fell within the “minor” discrepancy category.

KEY WORDS: Cervical spine, trauma, resident

Poster 210
Clinical Characteristics and Treatment Outcome in Patients with Spontaneous Intracranial Hypotension Treated by Multilevel High-Volume Spinal Epidural Blood Patch with or without Injection of Fibrin Glue
Aghaei Lasboo, A. · Hurley, M. · Walker, M. T. · Shepard, A. · Rahimi, S. · Yassari, A. · Shaibani, A.
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Chicago, IL

PURPOSE
To determine the clinical characteristics and treatment outcome in patients with spontaneous intracranial hypotension (SIH) treated by multilevel high-volume spinal epidural blood patch (EBP) with/without injection of fibrin glue.
Materials & Methods

We retrospectively studied eight patients with SIH due to spontaneous cerebrospinal fluid (CSF) leak, referred to us for evaluation and treatment from 2001 to 2007. Included patients met at least two of the following criteria: orthostatic headache, low CSF pressure on lumbar puncture, pachymeningeal gadolinium enhancement on cranial magnetic resonance imaging (MRI) or evidence of CSF leak on spinal CT myelography. None of the patients had a history of significant head or spine injury, although in three of them there was a history of possible trivial trauma following a fall or manual labor and strain during moving heavy equipment before starting the symptoms. An orthostatic headache was defined according to the criteria of the international headache society (1988) (1). All patients failed a period of conservative treatment prior to referral. Three patients also had already undergone unsuccessful EBP therapy in outside hospitals.

Results

Patient age range was 32-60 years (45 +/- 10.2) with a male to female ratio of 3:1. Presenting symptoms, in order of frequency, were: orthostatic headache (n = 8), nausea (n = 4), neck pain/stiffness (n = 3), lower back pain/stiffness (n = 2), shoulder pain (n = 2), drowsiness (n = 2), encephalopathy (n = 2), vomiting (n = 1), blurred vision (n = 1), and tinnitus (n = 1). Four patients underwent diagnostic lumbar puncture, three of whom had an opening CSF pressure recorded low (4-5 cm H2O). Characteristic gadolinium-enhanced MR brain features were present in five patients: two had isolated diffuse pachymeningeal enhancement, one had a subdural fluid collection and two patients had both of these features in addition to cerebellar tonsillar descent. CT brain without contrast was performed in two patients prior to EBP and revealed both subdural fluid collections and downward tentorial herniation. Five patients underwent CT myelography which revealed extravasation of contrast in all cases; however, radionuclide cisternography, performed in three patients, was unhelpful. One patient received a single high volume EBP with the remainder undergoing at least two - up to a maximum of four treatments. Two of the subjects underwent craniotomies to drain bilateral subdural hematomas, and one also required two additional percutaneous epidural fibrin glue patches. Follow-up results were recorded for seven patients. The median duration of follow ups was 10 months (4.5 months - 6.8 years) during which all seven patients remained stable with complete resolution of symptoms, including postural headaches.

Conclusion

Spontaneous intracranial hypotension has a wide range of clinical manifestations from benign to life threatening. When the diagnosis of SIH is confirmed, percutaneous minimally invasive image-guided interventions is an effective treatment modality.

References


Key Words: Spontaneous intracranial hypotension, epidural blood patch, fibrin glue patch

Poster 211

CHARITÉ™ Lumbar Artificial Disk Replacements: A New Means of Coronal Assessment in Multilevel Cases

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Purpose

A comparative analysis of CHARITÉ™ artificial disk replacements after multilevel procedures would provide a useful means of assessing their respective instabilities in the coronal plane. The best methods to assess coronal alignment after total disk replacement remain unclear. The accuracy of measurements obtained from these radiographs relies on landmarks selected to determine spinal angulation. Previous reports have questioned the value, reproducibility, and accuracy of several radiographic methods. The Cobb angle provides the only standardized means of analyzing overall coronal spinal alignment. However, previous studies have shown the Cobb method to be imprecise and susceptible to measurement error. Moreover, the Cobb angle does not directly take into account any potential implant subsidence or misplacement, and by definition only measures end plates above and below the vertebral levels involved. We propose a novel spike method of analyzing coronal balance after multilevel total disk replacement (TDR) in the lumbar spine. Clinically valid conclusions can be drawn based on interobserver and intraobserver radiologic findings. These radiographic measurements then can be correlated with clinical outcomes to determine the relevance of coronal plane instability.

Materials & Methods

A retrospective review of lumbar TDR on standard Anteroposterior, Ferguson view radiographs. All radiographs were digitized and reviewed independently by three spinal surgeons, and one radiologist using Kodak Carestream PACS (Eastman Kodak, Rochester, New York). To assess intraobserver variability, measurements will be repeated with a delay of at least 1 week between repeated measurements on the same scan. Observers will be blinded to any identifying information on the radiographs. The mean of the values obtained from each observer will be considered as the final value. Intraobserver and interobserver reliability of our measurements then can be assessed with use of correlation coefficients. Afterwards measurement variability can be calculated using standard statistical methods.

Results

Twenty-six patients (57 TDRs) were treated with multilevel Charite artificial disk replacements and available for an average long-term follow up of 1 year. In 13 patients the level L4-L5 and in another 13 patients level L5-S1 were measured with the Cobb and the spike method on Anteroposterior, Ferguson view x-rays after multilevel TDR. Both methods were adopted as landmarks and used the spikes of the prosthesis instead of the end plates (spike method) and the Cobb method utilized the whole vertebral body end plates or pedicles when necessary for determination. Measurements were performed by four experienced observers. The adopted spike method showed a better reliability compared to the reported results of the standardized Cobb method. The spike method used was clinically relevant for intraobserver reliability and for interobserver reliability for four experienced observers (95%-C.I.: p<0.001).

Conclusion

Spontaneous intracranial hypotension has a wide range of clinical manifestations from benign to life threatening. When the diagnosis of SIH is confirmed, percutaneous minimally invasive image-guided interventions is an effective treatment modality.
CONCLUSION
The spike method of assessing coronal alignment after TDR is a reliable method for studying protocols dealing with angular motion and clinically valid conclusions can be drawn with an accuracy of about +/- 2 degrees for the same observer and with an accuracy of about +/- 3 degrees for a different observer. These radiographic measurements then can be correlated with clinical outcomes to determine the relevance of coronal plane instability.

KEY WORDS: Arthroplasty, disk, alignment

Poster 212
Withdrawn
Scientific Exhibit 1

Use of MR Imaging-Angiogram Fusion Technique in the Diagnosis of Intracranial Vascular Lesions

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PURPOSE
Evaluate the significance of routinely using MRI-angiogram fusion technique in intracranial vascular anomalies for the diagnosis and proper localization of the lesion and in the planning of the treatment (i.e., endovascular treatment and surgical resection).

APPROACH/METHODS
Although in our institution patients harboring intracranial vascular malformations (AVMs or dural AVFs) and patients presenting with unruptured aneurysms, routinely undergo MRI with global acquisition and also a 3D rotation angiogram. For the purpose of the present study we reviewed 10 exemplary cases. The MRI exam is performed on a 1.5T GE Signa Excite unit using global imaging sequence (TR 23 ms, TE 8 ms matrix 512 x 512, slices of 1 mm in thickness with 1 mm separation). The 3D rotational angiogram is obtained during the conventional diagnostic angiogram using two different injection rates depending on the vessel caliber: for small caliber arteries 2 ml/sec for a total of 10 mls, for larger caliber arteries 3 ml/sec for a total of 15 mls.

The appropriate software (GE adw 4.2 workstation using the volume viewer software) is used to fuse the images obtained with the MRI and 3D rotational angiogram. The precise identification of the chosen artery in the three orthogonal planes (coronal, sagittal and axial) of the MRI is mandatory.

FINDINGS/DISCUSSION
The MR-angiogram fusion images obtained have proved to be extremely helpful in the precise localization of the vascular malformations (AVMs and dural AVFs), improving the pretreatment planning mainly when a team approach is necessary (i.e., endovascular treatment prior to surgical resection). Using the PACs system the images are readily available in the operating room and of course they are a useful complement to the neuronavigation system. No additional investigation is required since both the MRI global imaging and the 3D rotational angiogram are part of the pretreatment assessment of these patients. The MRI-angiogram fusion has proved to be more useful in the cases of vascular malformations than intracranial aneurysms since the 3D rotational angiogram already provides all the necessary information. Occasionally the lack of adequate opacity of some component of the vascular malformation due to its small size may prevent a complete visualization of the lesion. This is particularly true for multiple sites of dural AVFs or slow flow dural AVFs. Finally, this technique is relatively time consuming since it requires strict precision and it definitely impacts on the technologist’s work.

SUMMARY/CONCLUSION
MRI-angiogram fusion has proved to be very useful in the pretreatment planning of vascular malformations (AVMs and dural AVFs). It is a time-consuming reconstruction technique which requires anatomical expertise and precision.

KEY WORDS: MRI, rotational angiogram

Scientific Exhibit 2

Intraindividual Crossover Comparisons of Gadobenate Dimeglumine with other Gadolinium Contrast Agents for MR Imaging of the CNS

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PURPOSE
To summarize intraindividual crossover comparison studies of gadobenate dimeglumine (Gd-BOPTA; MultiHance) vs comparator agents for MRI of CNS lesions.
In five studies, a total of 336 patients underwent 2 MR exams within 2-14 days, one with 0.1 mmol/kg of Gd-BOPTA and the other with the same dose of a comparator (Table 1, Refs 1-5). Blinded expert neuroradiologists assessed both sets of T1-weighted SE postcontrast images for qualitative and quantitative efficacy parameters. Statistical analyses (e.g., Wilcoxon signed rank test) were used to measure study group differences.

### FINDINGS/DISCUSSION

In the initial study by Colosimo, the sensitivity for lesion detection with Gd-BOPTA (93-100%) was markedly superior to that of comparator (65-73%) (1). The increase in lesion-to-brain (L:B) contrast of the main lesion was consistently greater with Gd-BOPTA than comparators relative to unenhanced contrast (143% vs 127%). In a follow-up study with Gd-DOTA, qualitative assessment by blinded readers revealed a significant (p ≤ 0.005) overall preference for Gd-BOPTA over Gd-DOTA (2). Gd-BOPTA-enhanced images were significantly preferred for L:B contrast, lesion delineation, internal lesion structure, and overall image preference. Quantitative assessment revealed significantly (p < 0.05) greater lesion enhancement with Gd-BOPTA than Gd-DOTA from 2 minutes postinjection. In the first published study vs Gd-DTPA, Knopp noted a significant (p < 0.05) preference for Gd-BOPTA over Gd-DTPA for the global assessment of contrast enhancement (3). Similarly, a preference for Gd-BOPTA was noted for all qualitative parameters. Quantitative evaluation revealed significantly (p < 0.05) superior enhancement for Gd-BOPTA compared with Gd-DTPA from 3 minutes postinjection. In the large-scale study by Maravilla, all three readers showed a significant (p < 0.0001) overall preference for Gd-BOPTA vs Gd-DTPA (4).

### APPROACH/METHODS

#### Summary of Enrolled Patients and Comparators

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Comparator(s)</th>
<th>Lesion Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colosimo, 2001 (1)</td>
<td>22</td>
<td>Gadodiamide (Gd-DTPA-BMA; Omniscan); Gdortrate meglumine (Gd-DOTA; Dotarem)</td>
<td>Intracranial metastases</td>
</tr>
<tr>
<td>Colosimo, 2004 (2)</td>
<td>23</td>
<td>Gadodiamide (Gd-DTPA-BMA); Omniscan; Gdortrate meglumine (Gd-DOTA; Dotarem)</td>
<td>High-grade glioma or metastases</td>
</tr>
<tr>
<td>Knopp, 2004 (3)</td>
<td>27</td>
<td>Gadodiamide (Gd-DTPA; Magnevist)</td>
<td>High-grade glioma or metastases</td>
</tr>
<tr>
<td>Maravilla, 2006 (4)</td>
<td>151</td>
<td>Gadodiamide (Gd-DTPA; Magnevist)</td>
<td>Brain or spine lesions</td>
</tr>
<tr>
<td>Rowley, 2008 (5)</td>
<td>113</td>
<td>Gadodiamide (Gd-DTPA-BMA; Omniscan)</td>
<td>Primary and secondary brain lesions</td>
</tr>
</tbody>
</table>

#### Scientific Exhibit 3

**Optic Radiation Tractography in Disease States: Seeing is Believing**

White, M. L. · Zhang, Y. · Hahn, F. J. · Oomjola, M. F. · Poage, D. D.

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**PURPOSE**

The optic radiations have a complex pathway in the human brain. It has been found to be challenging to accurately dissect the optic radiations by diffusion tensor imaging tractography. However, we have demonstrated successfully these tracts in normals. Knowing the optic radiation tractogram positions in numerous pathologies could be very important for surgical planning in patients with tumors to optimize surgical resection and potentially even radiation therapy. Cases of trauma, stroke and demyelination also may benefit from virtual dissection of the optic radiations and these dissections may help clarify how these diseases affect them. The virtual dissection of the optic radiations in disease to date has been limited.

We analyzed tractograms of the optic radiations to validate the technique and demonstrate the utility of its application.

#### APPROACH/METHODS

Twenty patients with pathology involving the optic radiations were imaged on 3 T MRIs (GE HDx, Philips Achieva X-series). Twenty-five of 26 directions of encoding were utilized. The tractograms were created with GE Functool or Philips FiberTrak software. The patients had metastatic disease, glioblastoma multiforme, meningiomas, traumatic injury, focal atrophy, ischemia, and multiple sclerosis. Correlation of the tractograms to patients’ symptoms and physical exams were made.

#### FINDINGS/DISCUSSION

The virtual dissections of the optic radiations successfully created tractograms in our patients. The tractograms of the optic radiations demonstrated the displacement of the optic radiations, destruction by atrophy, involvement by ischemia, and the ability to utilize tractography to map the location of multiple sclerosis plaques.

#### SUMMARY/CONCLUSION

At a dose of 0.1 mmol/kg, Gd-BOPTA-enhanced images of patients with CNS lesions demonstrated greater contrast enhancement, and were significantly preferred by experienced, blinded readers over an equal dose of comparator agent. Improved enhancement may lead to better diagnosis and staging of patients with neoplasms and other malignant processes.

**KEY WORDS:** Diffusion tensor imaging, optic radiation
Nonconventional Uses of FIESTA in Neuroimaging

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PURPOSE
Pictorial illustration of nonconventional uses of 3D fast imaging employing steady state acquisition (FIESTA) in neuroimaging.

APPROACH/METHODS
The utility of FIESTA in IAC region evaluation has long been recognized. We explore the nonconventional uses of this sequence.

FINDINGS/DISCUSSION
In the temporal bone, an exquisite detail of the membranous labyrinth can be obtained and is helpful in the diagnosis of small tumors, labyrinthitis and semicircular canal fistulas. Cranial nerves that are too small to be identified routinely on conventional imaging can be seen. 3D data set of this sequence which allows for multiplanar reformatting is very useful in the evaluation of neurovascular compression. The sequence well delineates aqueduct of sylvius and aids in the diagnosis of stenosis and web. It can be used as an adjunct to CSF flow studies in the evaluation of CSF dynamics in cases of posterior third ventricle, pineal region and tectal tumors. We often can visualize the surgical defect in third ventricular floor in cases of third ventriculostomy. The wall of the arachnoid cyst often can be delineated and hence its relation to surrounding vessels and nerves. A site for cystocisternostomy can be suggested. The sequence is helpful in the evaluation of complex cystic masses wherein there is a greater contrast between truly cystic component and the rest of the lesion. In situations of diagnostic difficulty the CSF cleft of the extraaxial masses can be demonstrated. In the setting of acute spine trauma, nerve root avulsion and pseudomeningocele formation are well demonstrated. The spinal cord syrinx and its internal architecture including septations are better demonstrated.

SUMMARY/CONCLUSION
Three-dimensional data of FIESTA has high spatial resolution, demonstrates high CSF-tissue contrast, amenable for multiplanar reformats and has multitudes of utility in neuroimaging.

KEY WORDS: FIESTA, MRI

Primary CNS Sarcoma: Neuroimaging with Neuropathologic Correlation

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PURPOSE
The aim of this exhibit is to familiarize clinicians with several uncommon to very rare mixed glial and mesenchymal neoplasms of the central nervous system, including gliosarcoma, oligodendroglioma with sarcoma (so called oligosarcoma) and subependymoma with sarcoma, through neuroimaging with neuropathologic correlation.

APPROACH/METHODS
Patient records were examined for the tissue diagnosis of CNS sarcoma. These patients were further selected for those who also underwent MRI of the brain within our system. The MRI images then were correlated with histologic pathology slides.

FINDINGS/DISCUSSION
A total of eight patients presented to our institution for evaluation and diagnosis of primary parenchymal CNS sarcoma between the dates of 12/11/03 and 10/18/07. There were four female and four male patients. The age range was from 43 to 84 years. In each case, divergent mesenchymal differentiation of a glial neoplasm was noted. The glial component was most often high grade and astrocytic in nature, as well as a single example with low grade oligodendrogial component and a single example with benign subependymal component were identified.

SUMMARY/CONCLUSION
These cases nicely demonstrate the potential of glial tumors which are derived from neuroectoderm to undergo divergent differentiation along mesenchymal lines. Unfortunately, imaging findings of primary CNS sarcoma are nonspecific compared to other primary brain tumors. However, the diagnosis may be considered on neuroimaging and sought on tissue biopsy if performed. The implications of this diagnosis at this time are debatable but there is evidence that there may be prognostic and treatment implications. Hopefully, this will become more evident as cases, such as these, are collected and examined.

REFERENCES

KEY WORDS: Neoplasm, gliosarcoma, oligosarcoma
Endovascular and Surgical Management of Acute Carotid Blowout Syndrome in Patients with Treated Head and Neck Cancer

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Purpose

The purpose of this exhibit is to review the current state-of-the-art in the management of acute carotid blowout. We also hope to illustrate some important points in the surgical and endovascular management of acute carotid blowout through our recent experience with the following two patients.

Approach/Methods

Case 1: A 60-year-old male presented with multiple episodes of brisk bleeding from his tracheostomy after recent hospitalization for management of a pharyngocutaneous fistula. One year earlier, the patient had undergone total laryngectomy, bilateral neck dissection, tracheostomy and radiotherapy for recurrent laryngeal squamous cell carcinoma. An emergent angiogram revealed a large pseudoaneurysm arising from the right common carotid artery with active extravasation medially toward the pharyngocutaneous fistula. A 6 mm x 40 mm Fluency covered stent was deployed in the right common carotid artery endograft. Cross-filling of the right anterior and middle cerebral arteries was demonstrated. The patient remained neurologically intact. Due to concern of a stent infection in a contaminated pharyngocutaneous field, the patient underwent neck exploration with removal of the covered stent and ligation of the right carotid artery. He continues to do well at 3-month follow up.

Case 2: A 62-year-old male presented with a sentinel bleed from his right neck. Earlier, he was noted to have skin breakdown with saliva extruding from the wound; findings that are suggestive of a pharyngocutaneous fistula. Two months earlier, this patient underwent a total laryngectomy, bilateral neck dissection, and tracheostomy. Emergent angiogram revealed active extravasation from the inferior thyroid artery. This branch was embolized using platinum microcoils. The following day, the patient had copious hemorrhage from his neck wound and was taken emergently to the operating room. Ligation of the internal carotid artery and the jugular vein was performed. The patient recovered without any neurologic deficit.

Findings/Discussion

Rupture of the carotid artery or carotid “blowout” is a rare but devastating complication following the treatment for head and neck cancer. Emergency surgical ligation of the CCA or the proximal ICA (without provocative testing) traditionally have been the only therapeutic options for patients with carotid blowout. Because of the high mortality associated with this condition, endovascular management has emerged as a quick and effective method with lower morbidity compared with an emergent surgical procedure. A few reports have described successful therapeutic coil embolization of the offending vessel and more recently, the use of covered metal stents has been described in the management of acute carotid blowout. While the use of endovascular techniques in the setting of profuse and active bleeding is certainly favored, one should remain aware of the possibility of a recurrent bleed after the initial endovascular rescue. In addition, the long-term consequences of placing a foreign body in a field with ongoing contamination have not been clearly defined and require further study.

Summary/Conclusion

In our opinion, endovascular rescue of carotid blowout remains an effective temporizing measure while a more permanent surgical solution is pursued.

Key Words: Carotid blowout, head and neck cancer

Scientific Exhibit 7

Functional MR Imaging Using Arterial Carbon Dioxide Modulation to Evaluate the Normal and Diseased Brain

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Purpose

To discuss current uses of arterial carbon dioxide (CO₂) modulation in combination with functional magnetic resonance imaging (fMRI) to study the human brain in health and disease.

Approach/Methods

Relevant articles obtained from a Medline data base search were reviewed. The authors also draw upon their own experience and research (1, 2).

Findings/Discussion

The vasoactive effects of CO₂ are well known and measurable by fMRI: increases in arterial partial pressure of CO₂ (P_CO₂) cause global cerebral vasodilation and increased fMRI signal; decreases in P_CO₂ cause vasoconstriction and decreased fMRI signal. P_CO₂ elevation (hypercapnia) can be induced by breath hold, inhalation of gas mixtures containing CO₂, or acetazolamide injection. P_CO₂ reduction (hypocapnia) is achieved through hyperventilation. It is widely believed that increasing P_CO₂ does not alter brain metabolism (3). Therefore, hypercapnia has been used to establish a nonmetabolic hemodynamic reference condition against which to estimate neural stimulus-induced changes in the rate of cerebral oxidative metabolism (CMRO₂) with fMRI. Such calibrated fMRI, although promising, relies upon hemodynamic modeling that is still investigational and dependent upon accurate determination of calibration constants. Cerebrovascular reserve or reactivity (CVR) is a measure of responsiveness to vasoactive stimuli. Diminished CVR correlates with the extent of vaso-occlusive disease and risk of infarction in patients with macrovascular stenosis and microangiopathy. Variable CVR also has been observed in brain tumors. Further fMRI investigation of vascular reactivity in brain tumors is warranted for its potential in diagnosis and staging. The fMRI response may be influenced by endogenous and pharmacologic vasoactive substances, normal variation in CVR, and cerebrovascular disease. Therefore, the interaction of global CO₂-induced hemodynamic changes and local hemodynamic effects of neural
stimulation has received considerable attention as a paradigm for hemodynamic baseline effects. A significant interaction has been demonstrated (1). Therefore, use of a CO₂-established reference condition, particularly in pharmacologic fMRI, has been proposed. Finally, the fMRI BOLD response is sensitive to large veins, which can be relatively distant to sites of neural activation and misleading. Normalization of BOLD fMRI data by a hypercapnic control condition is a practical means of minimizing contributions of large veins and mitigating fMRI variability.

**SUMMARY/CONCLUSION**
Functional MR imaging with P₃CO₂ modulation has demonstrated utility in various areas of neuroradiology and neuroscience. Measuring CVR is useful in evaluating cerebrovascular and possibly parenchymal disease. P₃CO₂-modulated fMRI control studies can be used to minimize misleading macrovascular responses, calibrate fMRI data for relative CMRO₂ estimation, and control for vasoactive effects of drugs, disease, and normal variability.

**REFERENCES**

**KEY WORDS:** Functional MRI, cerebral blood flow, blood oxygenation

**Scientific Exhibit 8**

**Effectiveness of Cilostazol for the Treatment of Chronic Cerebral Infarction in Comparison with Aspirin Evaluated by Measuring Cerebral Blood Flow and Cerebral Oxygen Metabolism with O-15 Positron Emission CT and by Estimating Cognitive Impairment**

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**PURPOSE**
Cilostazol, a potential intiplatelet agent, has been reported to have anti-cytotoxic effect and anti-apoptosis effect and to be more beneficial than aspirin for the treatment of chronic cerebral infarction. To evaluate the clinical utility of cilostazol to improve cerebral blood flow (CBF) and cerebral oxygen metabolism (CMRO2) estimated by O-15 positron emission CT (O-15 PET) scan as well as cognitive function in comparison with aspirin (AMA) treatment.

**APPROACH/METHODS**
Seven patients (two males and five females; age 63 to 79 years, average 69.3 years) with chronic supratentorial infarctions who had been treated by AMA more than a year were enrolled with informed consent. Patients with any recent stroke symptoms, hemorrhagic events, heart failure, severe liver or renal dysfunction and some medication that might affect the pharmacokinetics of cilostazol were excluded. Patients treated with AMA (81 to 100 mg/day) and with imaging study such as CT, MRI and/or SPECT were altered to 200 mg/day of cilostazol. Before and three to six months after the cilostazol treatment, patients examined blood pressure, pulse rates, blood tests (RBC, WBC, Hg, Ht, Plt, Total protein, AST, ALT, ALP, LDH, r-GTP, Total bilirubin, Na, K, Cl, BUN, creatinine, UA, CPK, cholesterol, serum glucose, HbA1c) and cognitive scales (MMSE).

**FINDINGS/DISCUSSION**
No enrolled patient dropped out from this study due to the adverse effect. PET scan demonstrated significant (average CBF: 37.0 to 43.9 mL/min/100g and average CMRO₂: 2.04 to 2.81 mL/min/100g), mild (average CBF: 42.5 to 45.0 mL/min/100g and average CMRO₂: 2.93 to 3.33 mL/min/100g), and no increase in CBF and CMRO₂ of bilateral frontal to parieto-occipital lobes in four, two, and one patients, respectively. These results were more obvious when regions of interest were set at bilateral basal ganglia and all cases shows mild to marked increase in CBF and CMRO₂. All patients but one revealed improved cognitive impairment and memory disturbance with cilostazol treatment (averaged MMSE: 18.3/30 to 27.4/30). These results were more obvious when regions of interest were set at bilateral basal ganglia and all cases showed mild to marked increase in CBF and CMRO₂. All patients but one revealed improved cognitive impairment and memory disturbance with cilostazol treatment (averaged MMSE: 18.3/30 to 27.4/30).

**SUMMARY/CONCLUSION**
In addition to the anticoagulation effect for platelets seen both aspirin and cilostazol, the direct mechanism of cilostazol onto the cerebrovascular endothelium via increase of cAMP and inhibition of lipopolysaccharide and TNF-α has been reported. In our result, O-15 PET study clearly demonstrated not only the increased CBF but also the improved cerebral metabolism. Since this study was limited in number and our patients were stable and not severely ill, more needs to be done to justify our results. However, we suggested that our results of the PET study might explain the improvement of cognitive impairment of our patients that was more dramatic than we had expected.

**KEY WORDS:** Cerebral infarction, cilostazol, PET
Scientific Exhibit 9

Invasive Aspergillosis of Central Nervous System: Impact of the Early Diagnosis on Favorable Therapeutic Results

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PURPOSE
Invasive central nervous system (CNS) aspergillosis easily leads to infarction and/or hemorrhage due to vascular involvement and has an extremely high mortality rate. Recently developed antifungal agents with new mechanisms have been reported to be effective against aspergillus species. We present cases in which early diagnosis or suspicion of invasive CNS aspergillosis could influence successful treatment.

APPROACH/METHODS
MR imaging of three patients (Case 1 with acute infarction and Cases 2 and 3 with ENT preoperative cases) with invasive CNS aspergillosis were evaluated prospectively. In three additional cases, MRI and pathologic correlations were performed retrospectively.

FINDINGS/DISCUSSION
Case 1: Diffusion-weighted MRI revealed hyper-intensity in right basal ganglia with atypical territory. T2 hypo-intensity mass was seen around left optic canal. The patient was treated effectively with voriconasole. Cases 2 and 3: Preoperative MRI revealed T2 hypo-intensity in paranasal sinuses and prevented the surgical deterioration of CNS aspergillosis. Cases 4 to 6: Widespread intracranial hemorrhage, infarction and multifocal mass lesions were demonstrated. Histopathologic study showed extensive vascular invasion of fungal hyphae and fungal abscess with bleeding. It is important to make the potential diagnosis of CNS aspergillosis as early as possible to achieve favorable results.

KEY WORDS: Aspergillus, MRI, antifungal agent

Scientific Exhibit 10

Revisiting the Cerebello-Pontine Angle

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PURPOSE
The aim of this exhibit is to review the embryology, anatomy and pathologic imaging commonly encountered at the cerebello-pontine (CP) angle. After reviewing this poster one will be able to formulate a well conceived differential diagnosis and convey the important radiographic information that would facilitate patient management.

APPROACH/METHODS
We studied most of the CP angle lesions that we came across in the last 2 years and have compiled a set of different pathologic conditions seen at the CP angle. They include common lesions like vestibular schwannomas, meningiomas, arachnoid cysts, lymphoma, epidermoid cysts, less common entities such as aneurysm (Fig. 2), glomus tumor, vertebral dolichoectasia as well as some intraaxial mimickers like radiation necrosis (Fig. 1), pontine or medullary gliomas, ependymomas, metastases, hemangioblastoma. Bony tumors of nearby structures (clivus, petrous bone, upper cervical spine) with pathologic entities that affect them such as choromas, chondrosarcomas, metastases, nasopharyngeal carcinoma, primary bony tumors such as fibrous dysplasia, plasmacytomas, abnormalities of bone formation of the skull base, infections, rheumatoid arthritis also are reviewed. Multidetector CT and high-resolution MRI have been used appropriately to evaluate the patients and formulate a correct diagnosis for optimum patient care.

FINDINGS/DISCUSSION
Cerebello-pontine angle masses are common posterior fossa lesions. They account for 5-10% of the intracranial neoplasm. Vital anatomical structures can be primarily or secondarily involved with resulting life threatening complications. A careful radiographic assessment is required to make the correct diagnosis, define an appropriate treatment plan and avoid unnecessary morbidity and mortality. Different treatments including observation, surgery, radiotherapy and rarely chemotherapy have been used in managing these patients. With advances in neurosurgical techniques, complete excision is planned for most cases of CP angle masses. Our poster depicts most of the expected CP angle lesions and highlights the important imaging features of each entity.

SUMMARY/CONCLUSION
This pictorial exhibit revisits important embryologic, anatomical and imaging characteristics of the cerebello-pontine angle. A relevant anatomical-based differential diagnosis is provided. Each entity is reviewed in great detail with particular emphasis on imaging characteristics that support the diagnosis. Important lessons are learned from some cases.

KEY WORDS: Cerebello-pontine angle, neoplasm, acoustic neuroma
Scientific Exhibit 11

Pictorial Essay: The Third Ventricle: Radiologic Anatomy and Pathology

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PURPOSE
The third ventricle possesses unique anatomical structures that can be well defined with modern imaging techniques of MR and CT. Our purpose is to depict the anatomy with display of the neural, vascular and cisternal anatomy of the third ventricle and surrounding structures and discuss radiologic characteristics of the unique lesions seen in this region and approach to their differential diagnosis. We also discuss advanced MR and CT techniques like diffusion, perfusion, CTA, volume reconstruction in 3D and CSF flow studies.

APPROACH/METHODS
We use high-resolution 3D volumetric thin section MR and CT images with and without contrast. Appropriate reconstructions in all three planes, along the plane of the third ventricle and 3D volume reconstructions are presented. We reviewed normal and abnormal CT, MR and ultrasound images performed on our pediatric and adult population and discuss the various differences of anatomy and pathology. These images serve as the case material for this exhibit. We describe common and uncommon lesions found in the region of the third ventricle and discuss differential diagnosis. Discussion of studies evaluating advanced microsurgical techniques will be presented.

FINDINGS/DISCUSSION
We present the imaging anatomy of the third ventricle using CT, MRI and ultrasound. Cases showing unique and characteristic features of various abnormalities of the third ventricle will be shown. They include cases of colloid cyst (Fig 1), tuber cinereum hamartoma, subependymal giant cell astrocytoma, infundibular lesions, ependymoma, choroid plexus papilloma, hypothalamic glioma (Fig 2), suprasellar and pineal tumors, aqueductal abnormalities, vascular abnormalities in and around the third ventricle, metabolic diseases and degenerative diseases. Lesions of structures surrounding the third ventricle (e.g., interhemispheric fissure, suprasellar cistern, quadrigeminal plate cistern, corpus callosum, cistern of velum interpositum and midbrain) that may secondarily affect the third ventricle are discussed also. We demonstrate the pitfall of flow artifact at the foramen of Munro and show how to avoid it using multiple planes.

SUMMARY/CONCLUSION
Knowledge of anatomy of the third ventricle is important in order to arrive at a reasonable diagnosis or differential diagnosis for lesion in the third ventricle. This exhibit outlines the approach to diagnose third ventricular lesions.

KEY WORDS: Third ventricle, anatomy, pathology

Scientific Exhibit 12

Imaging of Mass Lesions in Posterior Third Ventricular Region

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PURPOSE
Posterior third ventricular region lesions include lesions of the pineal gland and lesions arising from the adjacent structures (parapineal lesions). The clinical presentation of these lesions is due to compression of adjacent structures and include hydrocephalus, Parinaud’s syndrome or endocrinologic abnormalities.

APPROACH/METHODS
A pictorial depiction of the imaging findings in didactic format will be presented. The various lesions in the posterior third ventricular region are described in this educational exhibit with the literature concerning them reviewed, with emphasis on the imaging features, MRI and diffusion findings.

FINDINGS/DISCUSSION
The pineal lesions include: pineal parenchymatous lesions including pineoblastomas and pineocytomas; germ cell tumors; pineal cysts. The parapineal lesions include: gliomas from tectum, thalamus; meningiomas of tentroium; papillary tumors; metastases. Imaging features of these lesions including the homogeneity of the lesions, presence of cystic/necrotic areas, engulfment or explosion of pineal calcification or presence of calcification within the lesion and features on diffusion and perfusion imaging of these lesions are reviewed.

SUMMARY/CONCLUSION
This exhibit will help a radiologist to identify the various imaging patterns of posterior third ventricular lesions, pineal parenchymatous, germ cell tumors and parapineal lesions and to distinguish them. To understand the role of various modalities in differentiating these lesions.

KEY WORDS: Posterior third ventricular region, MRI, pineal
Scientific Exhibit 13

Referred Otalgia: Spectrum of Imaging Findings

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PURPOSE
The purpose of our exhibit is to clarify the sensorineural pathways involved with referred otalgia, and to review typical CT and MR imaging presentations for disease processes producing referred ear pain.

APPROACH/METHODS
This exhibit will pictorially review the most commonly affected referred otalgia sensorineural pathways, emphasizing cranial nerves 5, 7, 9, 10, and spinal nerves C2 and C3. Illustrative CT and MR images in patients with referred otalgia will be included. Cases will be clustered according to the individual referred neural pathways involved.

FINDINGS/DISCUSSION
CN 5 is the most frequent pathway for referred otalgia via the auriculotemporal branch of the trigeminal nerve. Tumors and infections of the nasal cavity, paranasal sinuses, and salivary glands can all be sites of distant pathology causing referred ear pain. Referred ear pain from dental lesions may be the most common perpetrator within this neural pathway. CN 7 produces referred otalgia via the auricular branch of the facial nerve. Bell’s palsy can present as ear pain, antecedent to facial paralysis. CN 9 mediates otalgia via the tympanic nerve of Jacobson. Pathology involving the tonsils, nasopharynx, parapharyngeal and retropharyngeal spaces can all produce referred otalgia. Eagle’s syndrome can irritate the glossopharyngeal nerve via an elongated styloid process. CN 10 is involved with otalgia via the auricular nerve of Arnold. Infection, tumor, or ulceration of the larynx, trachea, thyroid and epiglottis can result referred otalgia. Spinal nerves C2 and C3 produce referred otalgia via the Greater and Lesser Auricular nerves. Cervical arthritis, disk disease, and tumors can all present with otalgia.

SUMMARY/CONCLUSION
Referred otalgia can be a diagnostic dilemma for the clinician as well as the imager. After reviewing this exhibit, one should be able to: 1) Identify typical CT and MRI imaging presentations for disease processes resulting in referred otalgia. 2) Propose a cohesive differential diagnosis for otalgia given a history of ‘ear pain’ in the setting of an unremarkable ear examination.

KEY WORDS: sensorineural pathways

Scientific Exhibit 14

Spectrum of Central Nervous System Arteriovenous Fistulas: A Comprehensive, Case-Based Review

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PURPOSE
Depending on location, the signs and symptoms of central nervous system (CNS) arteriovenous (AV) fistulas can differ drastically. Intracranial AV fistulas can result in symptoms such as chemosis, pulsatile tinnitus and hemiplegia and signs such as subarachnoid hemorrhage, proptosis, and infarct. Spinal AV fistulas are more likely to present with symptoms such as weakness, back pain, and myelopathy and with signs such as myelitis. Whatever the etiology, the patient usually does not present until there is substantial venous hypertension and the damaging sequelae have occurred. It is therefore important for the radiologist to be able to appreciate different AV fistulas in the CNS both in the early and more chronic setting. After this presentation, the viewer should: 1) Gain a better understanding of the different types of CNS fistulas (i.e., direct vs indirect, dural vs pial); 2) Be able to identify CNS fistulas on MR, CT, and conventional angiography; and 3) Understand the different therapeutic options for these fistulas.

APPROACH/METHODS
A 5-year retrospective search was performed to identify patients at our institution who had confirmed fistulas of the CNS.

FINDINGS/DISCUSSION
The imaging characteristics of intracranial and extracranial fistulas will be demonstrated using multiple modalities. Intracranial examples will include carotid-cavernous fistulas (indirect and direct), occipital artery/transverse sinus fistula, and spinal dural arteriovenous fistulas. Treatment options including embolization vs surgical ligation vs combination procedures and post-treatment imaging will be presented.

SUMMARY/CONCLUSION
This comprehensive review will give the viewer a better understanding of the symptoms, correlative imaging findings, and therapeutic options in patients with CNS AV fistulas.

KEY WORDS: Fistula, dural
**Scientific Exhibit 15**

**Who's on Third? Causes of a Cranial Nerve III Palsy**

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Manhasset, NY

**PURPOSE**

The clinical presentation of a third nerve palsy often is acute and dramatic frequently requiring emergent workup and treatment when the cause is an expanding aneurysm. The clinical presentation is often a key factor in determining the imaging algorithm to follow when working up this clinical finding. However, the differential diagnosis of this clinical sign is extensive. Better understanding of the pathologic processes responsible for third nerve palsy can be achieved by understanding the anatomy of the oculomotor nerve (cranial nerve III) and its surroundings. Disease states that involve the nerve are divided into three basic categories: vascular, neoplastic and infectious/inflammatory lesions. After viewing this exhibit, the viewer should have an excellent understanding of the anatomy of cranial nerve III, the imaging algorithm(s) used to evaluate a third nerve palsy and the disease processes that affect the oculomotor nerve.

**APPROACH/METHODS**

A five-year retrospective evaluation of our data base was performed to identify patients that presented to our hospital with a third nerve palsy.

**FINDINGS/DISCUSSION**

The anatomy of the third cranial nerve and its relationship to the intracranial structures, orbital structures and calvarium will be examined carefully. Imaging of the third cranial nerve and the structures surrounding it will be highlighted. The etiologies of a third nerve palsy including: 1) Vascular: posterior communicating artery, basilar tip, and superior cerebellar aneurysms as well as cavernous sinus-internal carotid artery fistulas and ischemic disease; 2) Neoplastic: meningiomas, schwannomas, lymphoma and leptomeningeal carcinomatosis; and 3) Infectious/inflammatory processes such as sarcoidosis and Lyme disease will be demonstrated.

**SUMMARY/CONCLUSION**

The presentation of third nerve palsy, the imaging findings and the understanding of the various etiologies responsible for this clinical sign are the best clues as to “Who’s on Third”.

**KEY WORDS:** Aneurysm, third nerve palsy

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**Scientific Exhibit 16**

**Intracranial Aneurysms Mimicking Neoplastic Lesions: Pictorial Review**

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University of Kentucky
Lexington, KY

**PURPOSE**

Familiarize radiologists with the cross-sectional imaging appearance of intracranial aneurysms possessing an unusual imaging appearance mimicking neoplastic lesions.

**APPROACH/METHODS**

We present several illustrative cases of intracranial aneurysms initially evaluated at or referred to our institution with the diagnosis of an intracranial tumor. We also will compare and contrast the appearance of the aneurysm with its neoplastic counterpart.

**FINDINGS/DISCUSSION**

Intracranial aneurysms are a commonly encountered occurrence on cross-sectional imaging. While rupture and subarachnoid hemorrhage is the most feared complication of intracranial aneurysms, aneurysms may occur in unusual locations or have an unusual appearance mimicking a neoplastic process (e.g., meningioma, pituitary adenoma, pineal tumor, glioma).

**SUMMARY/CONCLUSION**

It is imperative for radiologists to recognize and preoperatively diagnosis intracranial aneurysms that may mimic neoplasms. Failure to do so may result in attempted biopsy or resection of these vascular lesions with potentially devastating consequences.

**KEY WORDS:** Aneurysm, cerebral, tumor

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**Scientific Exhibit 17**

**Hyperintense Skull Base Lesions on T1 Imaging Mimicking Cerebral Aneurysms with Time-of-Flight MR Arteriography**

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University of Kentucky
Lexington, KY

**PURPOSE**

To familiarize radiologists with the imaging appearance of skull base lesions that mimic intracranial aneurysms.

**APPROACH/METHODS**

We will review the imaging appearance of skull base lesions that have a hyperintense appearance on T1-weighted imaging, mimicking cerebral aneurysms on time-of-flight MR arteriography, and presented to our facility for treatment of the aneurysm.
FINDINGS/DISCUSSION
Not uncommonly inflammatory changes within the sphenoid sinuses may present with increased signal on T1-weighted imaging. Very commonly petrous apex granulomas possess this imaging characteristic. Time-of-flight angiography techniques are susceptible to “shine through” artifacts from incomplete saturation of such lesions with short T1 values, and may mimic cerebral aneurysms.

SUMMARY/CONCLUSION
When evaluating aneurysms of the skull base, particularly of the petrous and cavernous carotid arteries, it is imperative that radiologists fully examine the source images to exclude a “shine through” effect of skull base lesions on the maximum intensity projection images. It may be necessary to obtain routine MR imaging for confirmation.

KEY WORDS: Aneurysm, mimick, MRI

Scientific Exhibit 18
Unwanted Central Nervous System Effects of Radiation Therapy
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PURPOSE
Radiation therapy (XRT) is a major treatment modality for a majority of the central nervous system (CNS) and non-CNS neoplasms, as well as a number of other disease processes. However, the CNS is a major dose-limiting organ in XRT due to radiation injury which may have asymptomatic imaging findings or devastating clinical consequences. The underlying mechanism of injury is supposed to be a continuous, dynamic, and interacting process. Expectedly, the resultant radiologic findings cover a wide spectrum of abnormalities; however, to date, a comprehensive study demonstrating the imaging features of the gamut of secondary and unwanted CNS effects of radiation therapy has not been described. The purpose of the exhibit is to describe the MR and CT findings of various unwanted CNS effects of radiation therapy.

APPROACH/METHODS
Retrospective review was performed of MR and CT images at our institution over the past five years of patients at Henry Ford Hospital with a history of radiation therapy given for various pathologic processes that developed unwanted CNS effects. Pathology correlation was made with biopsy and resected lesions.

FINDINGS/DISCUSSION
Retrospective review demonstrated a wide spectrum of CNS insults with characteristic and salient imaging features on MRI and CT following XRT. Based on our spectrum of findings we elected to divide radiation injury or unwanted CNS effects of XRT into: 1) parenchymal injury to the brain or spinal cord or radiation necrosis (from being included in the radiation portal field) ranging from acute, subacute, to chronic injury; 2) radiation-induced vascular injury such as vasculitis, induction of vascular malformations such as cavernomas, telangiectasias, blow out or radiation-induced aneurysmopathy, as well as carotid stenosis; 3) development of secondary CNS tumors; and 4) unwanted osteous manifestations such as osteoradionecrosis. Teaching cases of various conditions will be included to enhance the exhibit.

SUMMARY/CONCLUSION
To date, a comprehensive study of the unwanted CNS effects of radiation therapy has not been performed. Our study details the important MR and CT imaging features of the broad range of CNS pathology that may occur secondary to radiation therapy.

KEY WORDS: Radiation, injury, central nervous system

Scientific Exhibit 19
Brain Abscesses Caused by Streptococcus intermedius: A Series of Eight Cases, Including a Previously Unreported Rare Presentation Involving the Splenium of the Corpus Callosum

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PURPOSE
Streptococcus intermedius, a member of the S. anginosus group, is primarily the causative pathogen for abscesses outside the central nervous system, such as in the liver. Brain abscesses caused by Streptococcus species are most often attributed to other groups such as S. viridans. We report eight cases of S. intermedius brain abscesses, including one with rare involvement of the splenium of the corpus callosum, a structure whose dense myelinated fibers are a barrier to all except a few aggressive or demyelinating processes. This series illustrates the importance of imaging techniques such as diffusion-weighted MRI and MR spectroscopy in differentiating cerebral abscesses from other disease entities.

APPROACH/METHODS
A retrospective review of the microbiology database at our institution from 1997-2007 revealed eight cases of brain abscess caused by S. intermedius. Of these eight cases of ring-enhancing lesions, three had CT only. All cases with MRI showed increased signal on MR diffusion-weighted sequences and low signal on apparent diffusion coefficient (ADC) maps. One patient also had MR spectroscopy that showed elevated lactate and amino acid peaks. The case of abscess involving the corpus callosum was without exception, showing a ring-enhancing lesion centered at the splenium with surrounding edema, increased signal on diffusion-weighted imaging and corresponding low signal on ADC maps. The remaining cases included abscesses in the frontal, parietal and occipital lobes, basal ganglia, thalamus and cerebellum. All abscesses were evacuated surgically and cultures were positive for S. intermedius.

FINDINGS/DISCUSSION
Cerebral abscesses are associated with a high mortality and early imaging diagnosis is important to ensure appropriate antibiotic and surgical intervention. Clinical diagnosis is dif-
ficult, with patients often presenting with nonspecific symptoms such as headache and fever. Abscess formation occurs in four stages: early cerebritis, late cerebritis, and early and late capsule formation. On imaging, brain abscesses are thought to demonstrate restricted diffusion due to increased viscosity and cellularity from the inflammatory response of the abscess content. MR spectroscopy also demonstrates elevated lactate and amino acid peaks due to anaerobic glycolysis and breakdown of protein products respectively. Members of the S. anginosus group are commensals of the oral cavity, nasopharynx and gastrointestinal tract. Odontogenic or frontal sinus sources may result in frontal lobe abscesses while those from the sphenoid sinuses may lead to temporal lobe or cerebellum involvement. Hematogenously spread abscesses may arise from cardiac or pulmonary origin, though in many instances the source remains unknown.

SUMMARY/CONCLUSION
When appropriate the possibility of an abscess caused by S. intermedius should be entertained in the differential diagnosis of ring-enhancing lesions, especially those occurring in unusual locations such as the splenium of the corpus callosum. An abscess in this location may mimic the appearance of tumor, metastasis, or a demyelinating process, and MR imaging, particularly diffusion-weighted imaging and spectroscopy, is invaluable in distinguishing these entities to ensure a timely diagnosis.

KEY WORDS: Abscess, corpus callosum, streptococcus intermedius

Scientific Exhibit 20
Imaging of Central Nervous System Parasitic Diseases

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PURPOSE
Due to the rising prevalence of AIDS and immunosuppressive therapy, parasitic infections in the central nervous system (CNS) have increased. Even though laboratory tests and biopsy remain the gold standard for diagnosis, neuroimaging plays an important role in the early and specific diagnosis of the disease. The purpose of this exhibit is to review the imaging findings of the most important parasitic diseases that affect the CNS.

APPROACH/METHODS
The method of investigation included gathering CT scans and MR images of patients with CNS parasitic diseases. We coupled that with a review of the literature. The CNS parasitoses reviewed include:

Protozoa
Amebiases: occurs in less than 1% of patients with dysentery. It causes a meningoencephalitis with single or multiple rim-enhancing supratentorial lesions mainly in the frontal lobes and basal ganglia.
Toxoplasmosis: the manifestations include hydrocephalus, microcephaly, and scattered calcifications in the congenital form. In the adult form, in immunocompromised patients, there are multiple ring-enhancing lesions located mainly in the basal ganglia, and cerebral hemispheres. A high apparent diffusion coefficient (ADC) value, a decreased relative cerebral blood flow on perfusion, and predominant lipid and lactate peaks on MRS are useful in differentiating toxoplasmosis from lymphoma. Malaria: brain imaging may be normal in 30-50%, and may manifest with diffuse edema with or without focal infarcts with predilection to the basal ganglia and cortex. Trypanosomiasis: African trypanosomiasis causes diffuse brain edema with scattered petechial hemorrhage, as well as meningeal enhancement on postcontrast images. In American trypanosomiasis, imaging shows multiple ring-enhancing tumor-like lesions.

Helminth Roundworms
Neurotoxocariasis shows multifocal cortical and subcortical lesions enhancing homogeneously. Baylisascariasis encephalitis shows periventricular white matter and brainstem abnormal signal accompanied with diffuse brain atrophy. Trichinosis: Lacunar infarcts, focal granulomas with nodular enhancement, and venous thrombosis are some of its features.

Tapeworms
Echinococcus: Cerebral hydatid, is usually a single well-defined thin walled cyst with no surrounding edema. Wall calcifications are rare. The presence of detached membrane or daughter cyst is pathognomonic. Cysticercosis: The imaging findings depend on the parasite’s location and the four developmental. The location can be in the brain parenchyma, intraventricular, subarachnoid, or in the spine. In the vesicular stage, there is a thin-walled cyst isointense to cerebrospinal fluid (CSF). At the colloidal vesicular stage, the cyst wall thickens with surrounding inflammation. At the granular stage there is nodular enhancement. And finally, there is the calcified stage. Sparganosis: There is widespread white matter degeneration, foci of petechial hemorrhage, and nodular pattern of enhancement. The lesions typically change in location due to the migration of the worm. Coenurus: The cysts, having CSF signal, cause ventricular obstruction and increased ICP.

Flukes
Cerebral Schistosomiasis: causes single or multiple tumor-like lesions with a unique “arborized” pattern. Paragonimiasis: imaging findings are typical with ring-like lesions resembling “grape clusters.”

SUMMARY/CONCLUSION
Understanding the different imaging findings of CNS parasitic diseases, along with laboratory analysis, serological tests, and brain biopsy, help in the early diagnosis which is important since these are potentially treatable diseases.

KEY WORDS: Parasitic infection
Scientific Exhibit 21

Evaluation of Brain Stem Lesions by Diffusion Tensor Imaging and Fiber Tracking at 3T Scanner

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PURPOSE
Even if they are benign in nature, lesions involving brain stem are always problematic for both radiologist and clinician. The purpose of this study is to evaluate the lesions involving stem with diffusion tensor imaging and 3D fiber tractography at 3T scanner and to demonstrate their relationship with white matter tracts.

APPROACH/METHODS
Case studies imaged at our imaging center were evaluated retrospectively. Cavernomas and pontin gliomas involving brain stem reviewed and compared with control patients. Special emphasize was given to the role of new techniques including diffusion-weighted imaging, diffusion tensor imaging and 3D fiber tractography.

FINDINGS/DISCUSSION
We tried to demonstrate deviations in imaging findings of white matter tracts passing through the brain stem due to different brain stem pathologies. Especially colored FA maps and 3D fiber tractography images were quite useful to demonstrate the relationship between lesion and white matter tracts, especially corticospinal tract.

SUMMARY/CONCLUSION
Newer imaging modalities including diffusion tensor imaging and 3D fiber tractography are quite sensitive to demonstrate white matter damage and/or distortions due to different pathologies. It is quite important to make a decision among treatment options. Also the tensor data are very useful to determine the operability of the lesions. 3T scanners are quite adequate to supply this data.

KEY WORDS: Diffusion tensor imaging, fiber tractography, brain stem lesions

Scientific Exhibit 22

Anatomy, Pathophysiology and Complications of Cerebral Venous Thrombosis: A Pictorial Review

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Thrombosis of the cerebral veins and sinuses is a distinct cerebrovascular disorder that usually affects children and young adults. This entity may represent with highly variable symptoms. Improvements in neuroimaging techniques and therefore early diagnosis of cerebral venous thrombosis with more effective available treatment options have led to significant improvement in the prognosis. More than 80 percent of all patients now have a good neurologic outcome. The purpose of this exhibit is to review the anatomy and normal variations of the cerebral venous structures and to discuss the pathophysiology of the cerebral venous thrombosis. The patterns of imaging with CT scan, MRI and conventional angiography will be discussed in cerebral venous thromboses and spectrum of potential complications will be illustrated including congestive venous encephalopathy, dural arteriovenous malformation, venous stroke, and carotidcavernous fistula.

KEY WORDS: Cerebral venous thrombosis, venous hyperten-

Scientific Exhibit 23

A Graphic User Interface of Semiautomated Brain Component Analysis for Multispectral MR Images

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PURPOSE
Volume quantification is important for understanding brain structure and diagnosis of subtle anatomical changes in variant brain diseases. Different approaches have been studied, but most of them were applicable in simultaneously quantitative measurement of gray, white matters and brain lesions. Recently, a new semiautomated segmentation method by incorporating with the independent component analysis (ICA) has been proved to be effective in classifying various brain tissues on multispectral MR images (1, 2). However, the method needs a tedious processing, which is not applicable in clinical utility. In this study, we tried to implement a convenient and comprehensive graphic-user-interface (GUI) of the semiautomated segmentation based on ICA coupling with a supervised supportive vector machine (SVM) for effective classification and volume measurement of brain MR images.

APPROACH/METHODS
The key idea of the ICA assumes that data are linearly mixed by a set of separate independent sources and these signal sources can be demixed according to their statistical independence measured by mutual information (1). Let x be a mixed signal source vector expressed by x = As (1) where A is an L×p mixing matrix and s is a p-dimensional signal source vector needed to be separated. The linear system equation described by (1) is actually an over-determined system, in which case there exists no solution. In order to mitigate the issue that more than one signal source accommodated in a single IC, a feature extraction-based classification technique SVM is included as a post-ICA processing technique to classify substances of interest. This system has been designed as a high-performance, comprehensive, object-oriented, MATLAB programming framework for the implementation of such applications. The input data of multispectral MR images, such as T1WI, T2WI and PDWI, were executed with a convenient and friendly interface. Initially, the
ICA was performed for separation of multispectral image data, and then followed by a supervised SVM for tissue classification. The output contains the images of independent components, the data of various brain tissues, and volume quantifications.

**FINDINGS/DISCUSSION**

Generally, it took a well-experienced operator several hours to manually process the “ICA+SVM” method for measurement of a whole brain MRI data set. The proposed GUI system allows a newcomer to easily execute the brain volume measurement and complete a measurement within 10 minutes. This system retains the flexibility of general scientific computing environments while adding a framework in which both experts and novices can develop and adapt brain tissue analysis methods.

**SUMMARY/CONCLUSION**

Our result revealed that the proposed GUI system could effectively perform the quantitative volumetric analysis of brain MRI. It would serve as an important and useful interactive tool for the clinician to study human brain and neurologic function.

**REFERENCES**


**KEY WORDS:** Independent component analysis, graphical user interface, MRI

**Scientific Exhibit 24**

**Diagnostic Value of T2 Signal Hypointensity in the Sellar Region**

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Paris, FRANCE

**PURPOSE**

Most intracranial lesions appear with high signal intensity on T2-weighted images. The purpose of this study is to enhance the diagnostic value of low T2 signal intensities observed in the sellar/parasellar region.

**APPROACH/METHODS**

Retrospective study of MR imaging of the sellar region with a low T2 signal hypointensity. Size, shape, appearance, nature and accurate location of low T2 signal intensity, together with corresponding signal on T1-weighted images have been analyzed in normal structures, sellar and parasellar lesions, as well as posttherapeutic conditions.

**FINDINGS/DISCUSSION**

Normal sellar and parasellar T2 signal hypointensities are related to the presence of cortical bone, air, flow voids in normal and variant anatomical structures. Sellar/parasellar lesions demonstrating T2 signal hypointensity may be related to the inner presence of a high concentration of protein (Rathke cleft cyst, craniopharyngioma, hypersecreting pituitary adenoma, mucocele, tuberculoma or aspergilloma), clotted blood (hemorrhagic pituitary adenoma, pituitary apoplexy, Sheehan syndrome, or thrombosed aneurysm), calcification (craniopharyngioma, meningioma, chordoma or cartilaginous tumor), flow voids (aneurysm, hypervascular tumor or carotid cavernous fistula), and magnetic susceptibility effects (hemochromatosis, melanocytic tumor). After either medical or surgical treatment, T2 signal hypointensity may result from the presence of clotted blood, air or from the presence of packing material used during surgery.
SUMMARY/CONCLUSION
Knowledge of the nature, appearance and accurate location of a T2 signal hypointensity in the sellar region, together with the corresponding signal on T1-weighted image, assist radiologists in reaching correct diagnosis of sellar/parasellar lesions demonstrating such a T2 signal intensity.

KEY WORDS: T2 signal hypointensity, sellar region, T1 signal hyperintensity

Scientific Exhibit 25
Pictorial Essay of MR Imaging Findings of Progressive Multifocal Leukoencephalopathy
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Birmingham, AL

PURPOSE
Progressive multifocal leukoencephalopathy (PML) is a rare demyelinating disease of the central nervous system caused by reactivation of JC virus. Before the HIV era, the disease was a rare complication of immunocompromised states including hematopathies, malignancy, collagen vascular disease and organ transplantation. Since the 1980s, PML has become much more prevalent in AIDS patients. Until the end of the last century, PML was a fatal disease, with death occurring within months of diagnosis. With the advent of relatively effective therapy the survival has prolonged. The disease has some characteristic imaging manifestations that neuroradiologists should be aware of. These should facilitate diagnosis or at least raise the suspicion of PML in a correct clinical setting.

APPROACH/METHODS
The MR imaging findings were reviewed in 13 patients. In all patients T2, FLAIR, diffusion-weighted and pre and postcontrast T1 images were obtained. We found that all these sequences contributed to the correct diagnosis of the disease.

FINDINGS/DISCUSSION
We found three patterns of involvement in decreasing order of involvement: Cortical, peduncular (at the confluence of middle cerebellar peduncle, cerebellum and pons), and central (basal ganglionic/diencephalonic/callosal). The cortical lesions most commonly involved the subcortical white matter without any mass effect. On T1-weighted images the lesions classically appeared as hypointense areas adjacent to a cortical gyrus. None of the lesions enhanced on postcontrast images. On T2-weighted images they were heterogeneous hyperintense. Some of lesions showed multiple small very T2 hyperintense lacunae within a background of less intense T2 signal abnormality. On diffusion-weighted imaging, there were areas of diffusion restriction at the periphery of the lesions.

SUMMARY/CONCLUSION
As the spectrum of the disease gradually becomes broader, and there is available therapy that increases survival time, the diagnosis of the disease is becoming very important. With these characteristic MR findings in a patient with correct clinical setting, it is possible to raise the suspicion of the disease correctly in almost all cases, if not diagnosed on the first scan.

KEY WORDS: PML, MRI, diffusion

Scientific Exhibit 26
Retained Surgical Sponges following Craniotomies: Imaging Appearances and Complications
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Philadelphia, PA

PURPOSE
To emphasize the importance in correctly identifying retained surgical sponges following craniotomies, and discuss their potential complications.

APPROACH/METHODS
The radiology and pathology data bases for neurosurgical procedures at our institution were reviewed retrospectively for retained surgical sponges following craniotomies over a 5-year period. The CT and MR images were reviewed both to determine the imaging appearances of the retained surgical sponges and to identify potential complications in the adjacent brain.

FINDINGS/DISCUSSION
Three patients were identified that had retained surgical sponges following craniotomies. Indications for initial craniotomies included brain biopsy for suspected acute encephalitis, resection of a brain tumor, and decompressive craniectomy for mass effect. All three patients had postoperative CT studies that demonstrated a hyperdense serpentine foreign body in the surgical bed representing the retained sponge. Two patients had postoperative MR imaging studies. The retained sponges were hypointense on T1 and T2-weighted images and demonstrated susceptibility artifact on the gradient echo sequence. One patient in whom the retained surgical sponge was not identified prospectively developed a foreign body granulomatous pseudotumor, which was identified and removed 4 months after the initial surgery.
Axial CT in bone algorithm of a postoperative study in a 65-year-old man following a decompressive right craniectomy for increasing mass effect. Serpentine, hyperdense object (arrow) represents the retained surgical sponge.

**SUMMARY/CONCLUSION**

Retained surgical material and its related complications are infrequent occurrences, but have been well described as complications following abdominal and pelvic surgeries. In contrast, there is little reported regarding retained surgical sponges following craniotomies. It is important that the radiologist be aware of this entity and its potential complications, which include the formation of granulomas and abscesses. These complications may be mistaken for residual/recurrent neoplasms. We discuss the radiographic appearance of retained surgical sponges following neurosurgical procedures in three patients and discuss the complications.

**REFERENCES**


**KEY WORDS:** Intracranial gossypiboma, retained surgical sponge, foreign body
Fig. The images display a high resolution coronal image of lenticulostriate artery and another of left central retinal artery.

**SUMMARY/CONCLUSION**

IA-enhanced DSA is a new and useful tool to study cross-sectional anatomy of vessels that are not seen routinely on IV-enhanced angiographic techniques (standard CTA, MRA). These type of studies are performed ideally in a hybrid DSA-CT suite; however, if need arises, these can be performed safely even if the DSA and CT suites are physically separate.

**KEY WORDS:** Catheter-assisted, DSA, CTA

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**Scientific Exhibit 28**

**When Good Sinus Infections Go Bad: A Review of the Intracranial and Facial Complications of Sinusitis and Otomastoiditis**

Hughes, M. A. · Escott, E. J.

University of Pittsburgh
Pittsburgh, PA

**PURPOSE**
To review the relevant anatomy and the imaging appearance of complications of sinusitis and otomastoiditis.

**APPROACH/METHODS**
Sinus anatomy will be reviewed, with specific attention to structural relationships and anatomical variants which may predispose to certain complications. The imaging appearance of extrasinus complications of sinusitis and otomastoiditis will be reviewed utilizing an organized approach based on anatomical relationships. Intraorbital complications of sinusitis and the imaging appearance of invasive fungal sinusitis will be presented also.

**FINDINGS/DISCUSSION**
Computed tomography is often the initial imaging modality used in evaluating sinusitis and otomastoiditis, and is quite good at evaluating extracranial complications. However, MR is generally a more sensitive modality for detecting intracranial complications. It is important to both utilize the best imaging modality for a specific diagnostic question and to be well versed in potential complications of sinusitis and otomastoiditis. Specific sites of primary infection frequently are associated with specific complications. It is important for a radiologist to understand these associations, and develop a search pattern to detect early complications of sinusitis and otomastoiditis. These complications include: cerebritis, meningitis, subdural empyemas, dural venous sinus thrombosis, subperiosteal abscess, cavernous sinus thrombosis, orbital apex syndrome, Gradengro syndrome, and soft tissue complications such as a Bezold’s abscess and facial cellulitis.

**SUMMARY/CONCLUSION**

Sinusitis and otomastoiditis are common diseases. Although extrasinus and particularly intracranial complications of sinusitis and otomastoiditis are relatively rare, prompt diagnosis and familiarity with the specific complications and their imaging appearances is crucial to prevent or limit neurologic complications.

**KEY WORDS:** Sinusitis, complications

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**Scientific Exhibit 29**

**Jugular Foramen Region Imaging: Pictorial Review**

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**PURPOSE**
The educational exhibit will seek to provide a review of the imaging anatomy, important relationships, and pathologic entities occurring within and adjacent to the jugular foramen. Through the use of example illustrations, these entities are presented and reviewed with highlights of particular clinical importance. Histopathologic correlation is provided for select cases.

**APPROACH/METHODS**
Retrospective case review of a broad range of pathologically and clinically proved disease entities involving the jugular foramen accumulated from 1996-2007 at a tertiary referral center. The anatomical relationships and major disease processes for this location are reviewed with the appropriate differential diagnostic considerations and recommended imaging approaches for common clinical presentations. High quality images illustrate the findings and complement the succinct review of disease in this location. Examples of cases discussed include but are not limited to the following: hemangiopericytoma, glomus tumor, jugular bulb variants, meningioma, schwannoma, osseous lesions, infection, squamous cell carcinoma, and metastasis. Some of the cases will be accompanied by histopathologic correlation.

**FINDINGS/DISCUSSION**
The viewer of this exhibit will gain or refresh information about the anatomical relationships and disease entities involving the jugular foramen and the posterior skull base for clinical practice and preparation for certifying examinations. The images provided aid recognition with an emphasis on clinical context and differential diagnosis.
Lesions involving the jugular foramen 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:** Jugular, foramen, neoplasm

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**Scientific Exhibit 30**

**Imaging of Head and Neck Paragangliomas**

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Rochester, NY

**PURPOSE**

Learn the common locations of paragangliomas of the head and neck and where they originate from. To learn the imaging features of paragangliomas of the head and neck.

**APPROACH/METHODS**

Didactic poster presentation demonstrating the common locations of paragangliomas of the head and neck and the imaging hallmarks utilizing CT, MRI and angiography.

**FINDINGS/DISCUSSION**

Paragangliomas of the head and neck commonly originate from the paraganglia at four typical locations which derive their names: carotid body (carotid body paraganglioma), vagal nerve (glomus vagale), middle ear (glomus tympanicum), and jugular foramen (glomus jugulare). Also called glomus tumors, they arise from paraganglion cells of neuroectodermal origin frequently located near nerves and vessels. Paragangliomas account for 0.6% of all neoplasms in the head and neck region, and about 80% of all paragangliomas are either carotid body tumors or glomus jugulare tumors. The carotid body tumor often presents as a pulsatile, painless neck mass. The jugulare and tympanicum tumors commonly cause pulsatile tinnitus and hearing loss and may cause cranial nerve compression. Vagal paragangliomas are the least common and present as a painless neck mass which may result in dysphagia and hoarseness. CT characteristically demonstrates an avidly enhancing soft-tissue mass, MRI commonly demonstrates a salt-and-pepper appearance, and an intense blush is often seen on angiography.

**SUMMARY/CONCLUSION**

A pictorial essay demonstrating the four typical paragangliomas of the head and neck and their characteristic imaging findings utilizing CT, MRI and angiography.

**KEY WORDS:** Paragangliomas, embolization

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**Scientific Exhibit 31**

**Multiple Radiologic Patterns of Fibrous Tumors of the Head and Neck**

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Beirut, LEBANON

**PURPOSE**

The aim of this study is to present the different imaging aspects of a large spectrum of fibrous tumors of the head and neck confirmed by pathology.

**APPROACH/METHODS**

We retrospectively reviewed the charts and images of 24 patients (age: 20 ± 17 years, 12 men) operated between 1996-2006 in our institution and having pathologically confirmed fibrous tumor of the head and neck, including: fibromatosis coli, desmoids tumor, solitary fibrous tumor, myofibroma, dermatofibrosarcoma, nodular fasciitis, fibrosarcoma, ossifying fibroma, inflammatory myofibroblastic tumor and nasopharyngeal angiofibroma. Preoperative MRI was performed at 1.5T in 12 patients and CT scan was performed in 13 patients. The imaging findings were correlated with the histopathology results.

**FINDINGS/DISCUSSION**

The tumors were located in the meninges (N = 1), the brain parenchyma (N = 2), the orbit (N = 2), the paranasal sinuses (N = 8), the retropharyngeal space (N = 1), the submandibular space (N = 1), the oral cavity/the mandible (N = 6) and the pharynx (N = 3). On CT the tumors were isodense or heterogeneous when compared to the muscle on unenhanced exam, there was bony erosion in eight cases and they show heterogeneous or homogenous enhancement postcontrast administration. On MRI, the tumors exhibit hypointensity on T1WI and hypo/hypersignal intensity on T2WI when compared to the muscle. Hypointensity on T2 was seen in myofibromas and was related to the rich collagenous component of the tumor. T2 hypointense septae were observed in some myofibroma representing hypocellular collagen stroma insinuated into hypercellular area. On gadolinium-enhanced T1WI the lesions demonstrated hetero/homogeneous enhancement.

**SUMMARY/CONCLUSION**

There are various benign and malignant fibrous tumors that may involve the head and neck area; the diagnosis should be considered when the lesion exhibits T2 hypointensity on MRI. Knowledge of all the radiologic patterns is helpful in establishing a correct diagnosis of a head and neck solid mass.

**KEY WORDS:** Fibrous tumor, head, neck
Scientific Exhibit 32

**MR Appearance of Craniofacial Fibrous Dysplasia**

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Lexington, KY

**PURPOSE**
Review the MR appearance of craniofacial dysplasia.

**APPROACH/METHODS**
Review the MR appearance of fibrous dysplasia with CT correlation.

**FINDINGS/DISCUSSION**
MR is often the initial imaging modality employed in evaluation of craniofacial pathology. While generally displaying the characteristic “ground-glass” appearance on CT imaging, fibrous dysplasia often has a more heterogeneous appearance with MR imaging. With MR imaging, fibrous dysplasia often appears as an expansile bone lesion with a central “cystic” component mimicking necrosis and malignancy.

**SUMMARY/CONCLUSION**
The diagnosis of craniofacial fibrous dysplasia with MR imaging may be challenging. It is important for radiologists to recognize the heterogeneous nature of fibrous dysplasia to prevent unnecessary biopsy/resection or erroneous diagnosis of metastatic disease and upstaging of malignancies.

**KEY WORDS:** Fibrous, dysplasia, MRI

Scientific Exhibit 33

**How Imaging Findings Can Aid in Differentiating between the Different Mitochondrial Cytopathies**

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**PURPOSE**
The aim of this display is to review prominent diagnostic imaging findings, analyze frequency of certain imaging findings, and draw conclusions regarding the clinical utility of MR and CT imaging in diagnosing mitochondrial cytopathies.

**APPROACH/METHODS**
MR and CT findings of 11 original and 126 reported cases of major mitochondrial cytopathies were used to calculate frequency of certain imaging findings to illustrate the efficacy of MR and CT imaging in diagnosing mitochondrial cytopathies.

**FINDINGS/DISCUSSION**
Head and neck manifestations in HIV patients are extremely common; present in 40-50% of affected individuals. Infection and neoplasia are the most common pathologic manifestations, and understanding the different manifestations of HIV specific to an organ or system can aid the approach to head and neck imaging. We found MR and CT images to be adequate in demonstrating systematic radiologic diagnosis of commonly found infectious, inflammatory, and neoplastic manifestations of the head and neck.

**SUMMARY/CONCLUSION**
Using CT and MR imaging, head and neck manifestations of HIV infection can be divided into specific anatomical areas, thus facilitating illustration of infectious, inflammatory, and neoplastic pathologies.

**KEY WORDS:** HIV, neoplasm, infection
Scientific Exhibit 35

Categorization and Characterization of Lesions of the Orbital Apex

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Pittsburgh, PA

PURPOSE
The apex of the orbit is formed by the union of the lesser and greater wings of the sphenoid bone, and acts as an osseous tunnel for numerous neurovascular structures entering the orbit from the cranial vault. Lesions of the orbital apex are clinically important as they can have an adverse effect on vision. A broad range of lesions can occur here, and our purpose is to organize the pathologic processes which occur in the orbital apex into logical imaging differentials, establish an organized approach to image analysis, and present examples of representative lesions.

APPROACH/METHODS
We review the anatomy of the orbital apex and categorize and describe the pathologic entities that are encountered most frequently in this anatomically compact region, and identify imaging patterns that can help to narrow the differential diagnosis.

FINDINGS/DISCUSSION
Categories of orbital apex lesions include: neoplasms, inflammatory processes, infections, lesions causing extrinsic compression, and vascular lesions. This categorization provides an organized framework to facilitate a reasonable differential diagnosis. CT and MRI are the modalities of choice to evaluate and characterize orbital apex lesions, and imaging examples utilizing these modalities will be presented.

SUMMARY/CONCLUSION
The orbital apex is a clinically important anatomical region and hosts diverse pathologic processes, and an awareness of common imaging patterns can help to generate a focused differential diagnosis. A systematic categorical approach can be of help to neuroradiologists attempting to accurately characterize lesions in this area.

KEY WORDS: Orbit, apex

Scientific Exhibit 36

What’s That in Your Ear? A Pictorial Review of Lesions of the External Auditory Canal

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Pittsburgh, PA

PURPOSE
The external auditory canal is included on many of the imaging studies seen by neuroradiologists, but it is not often given extensive scrutiny. Nonetheless, a variety of lesions can involve the external auditory canal, including both benign and malignant processes. The purpose of this study is to review and categorize the spectrum of lesions that can involve the external auditory canal.

APPROACH/METHODS
The anatomy of the external auditory canal will be reviewed. Cases demonstrating external ear lesions, collected during routine case read out in the head and neck imaging section of a large tertiary care medical center, will be used to demonstrate the range of pathology that can affect the external auditory canal.

FINDINGS/DISCUSSION
Pathologic processes involving the external auditory canal can be divided into the following categories: Congenital, including entities such as external auditory canal atresia or hypoplasia and first branchial cleft anomalies; inflammatory/infectious processes including malignant otitis externa and cholesteatoma; malignant neoplasms, which may be primary to the external auditory canal and are due most commonly to squamous cell carcinoma, but occasionally can be salivary gland neoplasms, melanoma or lymphoma; secondary invasion from parotid or skull base neoplasms; benign neoplasms and vascular lesions including osteomas, hemangiomas, cerumen plugs and keratosis obturans; trauma, with temporal bone or condylar fossa fractures at times involving the external auditory canal; and occasionally, foreign bodies.

SUMMARY/CONCLUSION
A wide array of lesions can involve the external auditory canal either primarily or secondarily. As the external auditory canal is included on many imaging studies encountered daily in neuroradiology practice, the radiologist should be familiar with these lesions.

KEY WORDS: Temporal bone, external ear, neoplasm
domas, one occurred in the right cerebropontine angle, four arose from the petrous bone, one in the nasopharynx, and one in the occipito-cervical junction. One clival chordoma demonstrated the subarachnoid dissemination at the level of the thoracic spine after the proton beam radiotherapy. Two out of three intradural chordomas showed intratumoral hemorrhage and a dural hole was confirmed in one case during surgery. Intrapontine large cyst formation with significant mass effect to the brain stem was noted in two retroclival chordomas (Fig.1). One retroclival dormant lesion and one osteosclerotic lesion in the clivus (Fig. 2) was demonstrated with no contrast enhancement on MR imaging, and deemed as EP and BNCT, respectively.

**SUMMARY/CONCLUSION**

Imaging findings of cranial chordomas vary and may be misleading. Awareness of these protean imaging manifestations of cranial chordomas would be beneficial to radiologists.

**KEY WORDS:** Chordoma, notochord, benign notochordal cell tumor

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**Scientific Exhibit 38**

**Intralabyrinthine Schwannomas: Review of Anatomy, Pathology, Clinical Features from an Imaging Perspective**

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Henry Ford Hospital

**PURPOSE**

The purpose of this exhibit is to review the normal MR anatomy of the inner ear structures as well as explain the MR imaging features in patients with intralabyrinthine schwannomas. Intralabyrinthine schwannomas will be classified and correlated with color-coded diagrams to further understand the anatomy of the lesions.

**APPROACH/METHODS**

Normal MR anatomy of the internal auditory canal and the labyrinth will be reviewed. Teaching cases showing various variants of intralabyrinthine schwannomas including transmodiolar, intracochlear, intravestibular, vestibulocochlear, transmacular, and transotic schwannomas will be shown. Color-coded sketch diagrams will be incorporated to further define the anatomy of the lesion with respect to the normal structures of the inner ear. Finally, the differential diagnosis of intralabyrinthine schwannoma will be reviewed with inclusion of imaging examples of metastases, intralabyrinthine meningioma and labyrinthitis to enhance the exhibit.

**FINDINGS/DISCUSSION**

Intralabyrinthine schwannomas usually present with sensorineural hearing loss, vertigo, dizziness and sometimes with tinnitus. MR characteristics of intralabyrinthine schwannoma are of a soft tissue mass that replaces the fluid signal in the labyrinth that is hypo to iso-intense on T2, hypointense on T1, enhancing with contrast. The differential diagnosis for intralabyrinthine schwannoma includes labyrinthitis, intralabyrinthine hemorrhage, facial nerve schwannoma with dehiscence into the inner ear, metastases and intralabyrinthine meningioma.

**SUMMARY/CONCLUSION**

After viewing this exhibit, the radiologist should have a better understanding of the normal MR anatomy of the inner ear, as well as the appearance of intralabyrinthine schwannomas. The classification of intralabyrinthine schwannomas will be reviewed, and a better understanding will be gained by incorporating teaching cases with sketch diagrams. The radiologist also will be able to give a broad differential diagnosis of intralabyrinthine masses.

**KEY WORDS:** Schwannoma, anatomy, labyrinth
Early and Late Term Effects of Radiotherapy in Head and Neck Imaging: A Pictorial Essay

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Purpose
Radiotherapy is an important treatment modality for cancer, and is often used in conjunction with surgery and/or chemotherapy. Early and late term effects of radiotherapy range from mucositis in the early posttreatment phase, to late term radiation-induced sarcoma. The purpose of this exhibit is to demonstrate CT and MR findings of early and late term radiotherapy effects.

Approach/Methods
The medical imaging data base was reviewed for head and neck cases demonstrating early and late term effects of radiotherapy. Cases were categorized into three groups: 1) early effects, 2) subacute effects, and 3) late effects. The clinical and imaging features of these cases were reviewed.

Findings/Discussion
In the early effects group, mucositis is the most common imaging finding. In the subacute effects group, we present cases of: 1) neck fibrosis with hypopharyngeal stenosis, 2) mandibular osteoradionecrosis, and 3) soft tissue ulceration/necrosis. In the late effects group, we present a case of temporal lobe necrosis, and three cases of malignant tumor formation with a period of latency ranging from 12 to 28 years. These cases include: 1) an aggressive squamous cell carcinoma of the scalp 28 years following brain radiotherapy for astrocytoma (28-year latency), 2) a low grade fibrosarcoma of the left neck posterior triangle following treatment for nasopharyngeal carcinoma (12-year latency), and 3) a chondroblastic osteosarcoma following cranial radiotherapy for acute lymphoblastic leukemia (17-year latency).

Summary/Conclusion
The CT/ MR findings are presented for several early to late term effects associated with radiotherapy. Recognition of many of the early and subacute effects is essential to prevent further complication. The incidence of malignant tumor formation is likely to increase in the future due to improved survival in head and neck cancer patients. Early recognition of this late term complication with complete surgical excision is likely the best option for palliation and best chance for long term survival.

Key Words: Radiotherapy, head and neck cancer

Lower Cranial Nerve Pathology: A Segmental Approach

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Purpose
Utilize a systematic approach to evaluate and diagnose pathologies affecting the lower four cranial nerves.

Approach/Methods
We reviewed extensive teaching files from three institutions and selected the cases that demonstrated lower cranial nerve pathology. A review of the literature also was conducted.

Findings/Discussion
Patients with lesions affecting the glossoopharyngeal, vagus, spinal accessory and hypoglossal nerves usually present with cranial nerve palsy. When paralysis of one or more of the lower four cranial nerves is identified, complete evaluation of the nerves from their brainstem nuclei to their “end-organs” must be performed. For purposes of organization and discussion, this can best be accomplished by considering the nerves in five segments: 1) Brain stem/nuclear segment; 2) Cisternal segment - affecting the nerves as they transverse the cisterns; 3) Skull base segment - jugular foramen and hypoglossal canal; 4) Suprahyoid neck segment - affecting the nerves as they course through the suprahyoid carotid spaces; and 5) Infrahyoid neck/mediastinal segment - only affecting the vagus nerve. With this organization, a reasonable differential diagnosis can be constructed for pathologies in each segment (i.e., Neoplastic, inflammatory/infectious, traumatic and miscellaneous). It should be noted, however, that some lesions may affect the nerves in more than one segment (i.e., nerve sheath tumors may involve any segment other than the nuclear segment); paragangliomas can be located in the suprahyoid carotid and skull base segments.

Summary/Conclusion
The lower four cranial nerves can be affected by either an acute or chronic process that impacts the way the patient presents clinically. Knowledge of nerve pathways and relationships to surrounding structures is fundamental when evaluating patients with lower cranial nerve symptoms. A systematic “segment-based” approach helps narrow the differential diagnosis.

Key Words: Lower cranial nerves
Scientific Exhibit 41

Preoperative Embolization of Head and Neck Paragangliomas

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Rochester, NY

PURPOSE
Demonstrate the technical procedural aspects of preoperative embolization of paragangliomas and the potential pitfalls.

APPROACH/METHODS
Didactic poster presentation demonstrating selected paragangliomas of the head and neck, imaging findings utilizing CT, MRI and angiography, normal anatomy of the external carotid artery (ECA), and step-by-step angiographic images demonstrating preoperative embolization.

FINDINGS/DISCUSSION
Paragangliomas are hypervascular lesions and treatment is often times surgical. Preoperative embolization often is performed to reduce the tumor size allowing less surgical manipulation and decrease surgical blood loss. Paragangliomas are supplied by the ECA, commonly the ascending pharyngeal artery, however they may have multiple contributory branches. Understanding the anatomy of the ECA is essential for safe and effective embolization. Potential pitfalls include ECA branch connections to the vertebral and internal carotid artery system causing stroke or blindness. The imaging features of paragangliomas include avid enhancement on postcontrast imaging, intense blush on angiography, and the classic “salt and pepper” appearance by MRI.

SUMMARY/CONCLUSION
Educational poster demonstrating selected paragangliomas of the head and neck and the preoperative embolization. Understanding the anatomy of the ECA is essential for safe and effective embolization.

KEY WORDS: Paragangliomas, embolization

Scientific Exhibit 42

Evaluation of Treated Spinal Vascular Malformations with Contrast MR Angiography versus Follow-up Conventional Angiography

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PURPOSE
To demonstrate the accuracy of contrast-enhanced spinal MR angiography (MRA) in the evaluation of treated spinal vascular malformations as compared to conventional spinal angiography.

APPROACH/METHODS
We report 14 cases of spinal vascular lesions which underwent endovascular and/or surgical treatment. Post-treatment spinal MRA is compared with follow-up conventional angiography to assess for persistent or recanalized spinal surface vasculature, recurrent fistula or nidus, and myelopathy. Additional conclusions are reported for an additional six patients who underwent follow-up spinal MRA only after endovascular or surgical treatment.

FINDINGS/DISCUSSION
Fourteen cases of confirmed spinal vascular malformations (arteriovenous malformations and fistulas) diagnosed by both spinal MRA and conventional spinal angiography were treated with surgery or endovascular embolization between December 2003 and August 2007. Six treated spinal vascular malformations had both follow-up conventional angiography and spinal MRA. In all six cases, disappearance of abnormal spinal vasculature on spinal MRA correlated with findings on angiography. In addition, all six patients demonstrated resolution of the prior imaging findings of myelopathy which matched their clinical improvement. Secondary outcomes are reported in an additional six cases in which patients only had follow-up spinal MRA immediately, delayed and/or late relative to treatment, all of which demonstrated decreased vascular flow voids and high T2 cord signal, for which conventional spinal angiography was deferred. The remaining two patients had conventional angiography only which demonstrated normalization of the spinal vascularity.

SUMMARY/CONCLUSION
Contrast-enhanced spinal MRA is a noninvasive tool which can be utilized to assess efficacy of treatment, both surgical and/or endovascular, of spinal vascular malformations. In addition, spinal MRA in combination with conventional MR imaging performed at the same time offers the additional advantage of direct evaluation of the cord and the state of the patient’s myelopathic changes, the major cause of morbidity in these patients. Spinal MRA may obviate the need for catheter angiography when complete resolution of the malformation is demonstrated.

KEY WORDS: Spinal arteriovenous fistula
Scientific Exhibit 43

Added Information of Reconstructed Image of Rotational Angiogram in Interventional Neuroradiology

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PURPOSE
Since first introduction of three-dimensional (3D) reconstruction rotational angiography (RA), there have been multiple usages of it in interventional neuroradiology, especially aneurysm evaluation. But, there are few reports about reconstructed image of RA. We describe several cases where reconstructive image of RA gave added information in treatment planning and understanding anatomy.

APPROACH/METHODS
From March 2007 to November 2007 we did RA in 178 aneurysms, four carotid cavernous fistulas and six dural arteriovenous fistula. We evaluated conventional digital subtraction angiography, RA image and coronal reconstructed image.

FINDINGS/DISCUSSION
First coronal reconstructed image of RA gave added information in relation to coil mass, protruded loop, parent artery, stent, thrombus and aneurysm itself. Second, it gave additional role in treatment planning in carotid cavernous fistula. Third, it gave additional views in understanding anatomy of dural arteriovenous fistula.

SUMMARY/CONCLUSION
Reconstructive image of RA is useful in evaluation of aneurysm, carotid cavernous fistula and dural arteriovenous fistula. A 42-year-old man, who presented with unruptured aneurysm and was treated with endovascular coiling one year ago is now treated with stent-assisted revision embolization due to major recanalization.

KEY WORDS: Cerebral angiography, aneurysm, fistula

Scientific Exhibit 44

MR Imaging of Intracerebral Langerhans Cell Histiocytosis

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PURPOSE
Langerhans cell histiocytosis (LCH) is a rare systemic granulomatous disease that affects the central nervous system in up to 20% of the cases. The purpose of this exhibit is to review the imaging presentation of cranial LCH and to provide a guideline on how to perform and evaluate MR studies in LCH patients.
APPRAOCH/METHODS
The authors report on the imaging findings of more than 900 MR studies from 295 patients registered in the LCH CNS study center in Vienna, Austria.

FINDINGS/DISCUSSION
Intracranial LCH lesions may present as: a) enhancing tumorous lesions of the craniofacial bone and skull base with or without soft-tissue extension, b) lesions of the paranasal sinus and/or mastoid cells mimicking inflammatory changes c) enhancing intracerebral tumorous lesions (most frequent) in the hypothalamic pituitary region, Fig. 1A, d) intracerebral lesions with or without contrast enhancement, presenting as accentuated Virchow-Robi’n spaces, microangiopathy-like pattern or leukoencephalopathy-like pattern, e) so-called neurodegenerative changes (Fig.1B), and f) cerebral atrophy. Most of the pathology mentioned from a-d is rather unspecific by itself, but may point to the presence of LCH when occurring in combination or in the context of systemic LCH. To evaluate patients with suspected intracranial LCH we suggest thin coronal and sagittal T1-weighted sequences (to assess the pituitary region) axial T1-weighted sequences, covering the whole brain, axial T2-weighted sequences, and contrast-enhanced coronal T1-weighted. If enhancing lesions are detected, additional planes with or without fat saturation are suggested as indicated.

SUMMARY/CONCLUSION
Intracranial LCH has a broad spectrum of manifestations. To assess patients with intracranial LCH, a standardized MR study protocol should followed in addition to a systematic evaluation for potential intra and extracerebral sites of LCH involvement.

REFERENCES

KEY WORDS: Langerhans cell histiocytosis, neurodegenerative, granulomatous

Scientific Exhibit 45
Chronological Imaging Atlas of Normal Myelination
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PURPOSE
Demonstrate the imaging findings of normal central nervous system myelination starting from the fetus and ending with a normal pattern in a 7 year old.

APPRAOCH/METHODS
Pictorial atlas poster presentation of normal CNS myelination utilizing T1-, T2- and diffusion-weighted MRI. The pattern of progression of CNS myelination will be discussed and the role of imaging.

FINDINGS/DISCUSSION
Normal brain myelination is a process that begins during the fifth fetal month and continues in the postnatal brain. During the first months of life, the myelination process follows well defined steps. Myelination progresses from caudal to cephalad and from dorsal to ventral. The occipital lobes myelinate before the frontal lobes and the dorsal brainstem does so before the ventral brainstem. MR imaging studies suggest that white matter myelination can be considered as an indicator of functional brain maturation. From an imaging point of view, brain maturation can be followed in both T1- and T2-weighted images with brain myelination reaching adult appearance at an age of 2 years.

SUMMARY/CONCLUSION
CNS myelination progresses from caudal to cephalad and from dorsal to ventral in a predictable pattern by MRI. Myelination begins during the early fetal age and continues to 7 years of age. We will demonstrate the MR imaging findings in a pictorial atlas.

KEY WORDS: Myelination, pediatrics

Scientific Exhibit 46
Imaging of CNS Malformations: A Pictorial Review
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PURPOSE
Pictorial review of congenital central nervous system (CNS) malformations utilizing ultrasound, CT and MRI.

APPRAOCH/METHODS
Didactic pictorial poster presentation of CNS malformations utilizing ultrasound, CT, and MRI with discussion of the classification of congenital brain anomalies according to the stage of central nervous system development. We will present anencephaly, cephalcele, Chiari II, porencephalies, septo-optic dysplasia, posterior fossa malformations including Dandy Walker spectrum, schizencephaly, lissencephaly, heterotopias, and polymicrogyria.
FINDINGS/DISCUSSION
Congenital CNS malformation classifications are commonly based on Volpe’s classification which is divided into four major categories: dorsal induction, ventral induction, neuronal proliferation and neuronal migration. Dorsal induction is the first stage in the formation and closure of the neural tube and occurs at 3-4 weeks gestation. Failures of dorsal induction can lead to anencephaly, cephaloceles and Chiari malformations. During ventral induction during 5-8 weeks of gestation, a series of events leads to the formation of two separate cerebral hemispheres. Failure of this stage can lead to holoprosencephaly and posterior fossa malformations such as Dandy Walker spectrum. Disorders of neuronal proliferation, differentiation and histogenesis during 2-5 months of gestation include microencephaly, macroencephaly and neurocutaneous syndromes. During neuronal proliferation during 2-5 months of gestation, the vast majority of neurons are generated in the germinal matrix with differentiation and migration. Disorders during this phase leads to schizencephaly, lissencephaly, heterotopias and polymicrogyria.

SUMMARY/CONCLUSION
Congenital CNS malformation classifications are divided into four major categories according to the stage of CNS development and when the gestational disturbance occurred. We will present a multimodality pictorial review of CNS malformations.

KEY WORDS: Malformation, pediatrics

Scientific Exhibit 47
Pictorial Review of Moyamoya Disease
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PURPOSE
1) To provide an educational overview of moyamoya disease; 2) To review and illustrate CT, MR and conventional angiographic findings of moyamoya disease, particularly in the pediatric sickle cell population and 3) To review imaging findings and treatment of moyamoya disease after encephaloduroarteriosynangiosis (EDAS).

APPROACH/METHODS
The presentation will be in didactic poster format covering the following areas: 1) Background, pathophysiology, clinical findings and differential diagnosis; 2) CT, MR and conventional angiographic findings of moyamoya disease; and 3) Treatment and follow-up imaging of moyamoya disease with EDAS.

SUMMARY/CONCLUSION
Upon review of the presentation, the viewer should have an understanding of the clinical background, differential diagnosis, imaging findings and treatment of moyamoya disease, with particular focus on the pediatric sickle cell population.

KEY WORDS: Moyamoya, sickle cell anemia, pediatric
Cervical Spine Trauma: What to Do and What to Look For

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PURPOSE
1. To analyze the current opinion and controversies on optimal imaging work-up for assessment of patients with cervical spine trauma, with emphasis on the role of CT and MRI.
2. To determine changes in therapeutic management of patients with cervical spine trauma derived from the performance of MRI after CT.

APPROACH/METHODS
We reviewed clinical histories of 79 patients who underwent cervical spine MRI for suspected spinal cord injury or possible instability following cervical trauma. This is an open study with possibility of future inclusion of new patients. We point out new contributions of MRI contrasted to those brought on by CT. We make special emphasis on the MRI findings that went undetected on CT. We performed a revision of the state-of-the-art imaging work-up and consequent management of patients with cervical spine trauma.

FINDINGS/DISCUSSION
Most politrauma patients will require cervical spine imaging in view of the fact that 2-3% present injury to this site. There is great controversy referring to the indications of the different imaging modalities in the evaluation of cervical spine trauma. The same strategy cannot be used in all patients, since the severity of injury depends on the mechanism of lesion and on several clinical criteria, and hence it should be adjusted according with individual risk. We should clarify three questions: 1) Which patients require imaging studies?; 2) How many imaging studies are necessary?; 3) Exactly which imaging technique should be performed? Plain radiographs have been classically considered as the initial screening tool; however, a considerable percentage of lesions go undetected, especially in the cranio-cervical and cervico-thoracic junctions. Recently, its use as initial screening has been questioned and many consider it should be replaced by CT. CT offers numerous advantages: it is more sensitive and specific, more time- and cost-effective than radiography and, with the introduction of MDCT, spatial resolution in the MPR images has notably improved. MRI should be performed whenever there is neurologic deficit given that it is the only technique that allows assessment of the spinal cord. Likewise, it provides an optimal evaluation of ligamentous and soft tissue lesions. MRI detected a lesion of the spinal cord in all of the suspected cases due to neurologic deficit, except in one (brainstem lesion) and allowed differentiation of hemorrhage versus cord edema. Ligamentous injuries, epidural hematomas and disk lesions not suspected by CT were identified in 57% of the cases, determining instability with modification of the therapeutic approach. Unaccompanied ligamentous lesions without bone lesion were found only in isolated cases. Epidural hematomas, disk lesions or ligamentous injuries not suspected by CT were identified in 57% of the cases, determining instability with modification of the therapeutic approach.

SUMMARY/CONCLUSION
In selected cases, MRI is the optimal diagnostic tool for determining cervical spine instability and to assess the extension of a possible spinal cord injury. The findings obtained from MRI caused a change in the therapeutic management, generally towards surgery or fixation in approximately one out of every six patients.

KEY WORDS: Cervical spine, trauma, MRI

Role of Diffusion-Weighted Imaging with Apparent Diffusion Coefficient of Lumbosacral Spine and Pelvic Bone Lesions: Prognostic Implications in Patients with Multiple Myeloma

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PURPOSE
We present our preliminary results of the usefulness of diffusion-weighted imaging (DWI) with apparent diffusion coefficient (ADC) studies in determination of abnormalities involving the bone marrow of the lumbar spine and pelvis in patients with newly diagnosed multiple myeloma. These lesions were correlated with routine MR sequences of T1 and short T1 inversion recovery (STIR) weighted studies, positron emission tomography (PET) examination and bone marrow biopsy results.

APPROACH/METHODS
Forty-two patients with newly diagnosed myeloma underwent MRI, PET studies and bone marrow biopsy from August to October 2007. MR studies consisted of a complete survey of the axial skeleton including that of the lumbar spine and pelvis. Sequences performed were noncontrast and contrast T1 and STIR weighted studies of the lumbar spine and pelvis. Additional studies performed were DWI of the spine and pelvis with b values of 0, 400, 800 mm/sec with correlative ADC image. Positron emission tomography studies also were obtained in all patients. Bone marrow biopsy through an iliac site also was obtained.

FINDINGS/DISCUSSION
Patients with multiple myeloma showed variable MR appearances. Based on T1 and STIR weighted studies, 20 (47.6%) patients showed diffuse marrow involvement, 19 (45.2%) had macrofocal or microfocal disease and 3 (7.14%) had normal MR marrow study. The presence of diffuse or normal marrow involvement correlated well with marrow cellularity and plasma cell percentage on bone marrow biopsies. Macrophocal lesions directed marrow biopsy showing focal plasma cell involvement. In our study diffuse involve-
ment on DWI and ADC images showed hyperintensity on STIR (Image 1) and trace-weighted diffusion studies (Image 2) with hypointensity on ADC map (not shown). Normal marrow appearance showed hypointensity on both trace-weighted and ADC studies. Focal lesions showed focal hyperintensity on trace-weighted studies and hypointensity on ADC map. The presence of diffuse marrow involvement showed high standardized uptake value (SUV) (over 2). Focal lesions likewise showed high SUV usually greater than 3.

SUMMARY/CONCLUSION
In our study focal and diffuse lesions on DWI and ADC maps of the marrow of the lumbar spine and pelvis correlated well with bone marrow biopsy samples, guided marrow biopsies of focal lesions and overall correlated with SUV values on PET studies. We find DWI helpful in looking for additional focal lesions in patients with diffuse involvement. We are continuing this project in the follow up of this patient to predict tumor response to treatment in obtaining quantitative ADC values on treated lesions.

KEY WORDS: Diffusion-weighted imaging with apparent diffusion, lumbosacral spine and pelvic bone lesions, multiple myeloma

Scientific Exhibit 51
Vertebroplasty and Kyphoplasty: Getting Down and Dirty

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PURPOSE
Vertebroplasty and kyphoplasty are both well accepted procedures for the treatment of vertebral compression fractures. This exhibit presents an illustrative discussion and review of these procedures, focusing on the radiologic, gross anatomical, and microscopic appearances.

APPROACH/METHODS
We used a cadaveric spine to evaluate vertebroplasty and kyphoplasty. Twelve thoracolumbar vertebral levels were canalized and treated using these methods. Vertebral levels were alternated between vertebroplasty and kyphoplasty. Various approaches were utilized, including unilateral transpedicular, bilateral transpedicular, and parapedicular; and various amounts of polymethylmethacrylate (PMMA) cement were instilled into the vertebral bodies. Spiral CT images were obtained of the thoracolumbar spine prior to intervention, following kyphoplasty balloon inflation, following vertebroplasty needle placement, and following PMMA cement injection. Fluoroscopic images also documented each procedure. Each set of images was reviewed by an experienced reader. The cadaveric specimen then was submitted for gross dissection, and samples of the vertebral bodies were submitted for microscopic examination.

FINDINGS/DISCUSSION
Vertebroplasty and kyphoplasty share several similarities, as well as some very distinct differences, but both have proved to be effective in the treatment of vertebral compression fractures. In this exhibit, we detail the technical and anatomical considerations for both procedures, discussing the various approaches for needle placement, routes of potential egress, and possible complications. In addition, we also will compare the appearance and distribution of cement within the vertebral bodies, focusing on the interaction of the cement with the surrounding trabecular bone. The balloon inflation used in kyphoplasty creates a relatively well demarcated cavity, in which PMMA cement is deposited, creating a well defined interface between the cement and the surrounding bone. However, cement deposited during vertebroplasty demonstrates a more infiltrative pattern, intermingling with the surrounding trabecular bone. Microscopic evaluation clearly illustrates these differences. These interactive differences between the bone and cement carry theoretical implications for the durability of these procedures and risks of complication.

SUMMARY/CONCLUSION
In this exhibit, we offer an educational evaluation of vertebroplasty and kyphoplasty through detailed radiographic, gross anatomical, and microscopic illustration.

KEY WORDS: Vertebroplasty, kyphoplasty, osteoporosis
Acute Calcific Prevertebral Tendinitis: A Pictorial Review of Classic Multimodality Radiologic Findings with Suggestion of a Viral or Seasonal Component

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PURPOSE
Review the classic radiologic findings that differentiate retropharyngeal calcific tendinitis from other retropharyngeal processes such as abscess as well as suggest a possible viral or seasonal component to the development of this entity.

APPROACH/METHODS
We reviewed the available imaging studies (plain film, CT and MR) and clinical information obtained by our Otolaryngology department for three patients from a common geographic location who presented to our institution for neck pain during a 2-week period and ultimately were diagnosed with retropharyngeal calcific tendinitis.

FINDINGS/DISCUSSION
Retropharyngeal calcific tendinitis, also known as acute calcific prevertebral tendinitis and calcific tendinitis of the longus colli tendon, is a well described entity whose clinical presentation can mimic a retropharyngeal abscess. Awareness of this disease and knowledge of the characteristic imaging findings leads to an accurate diagnosis, preventing unnecessary antibiotic usage and invasive procedures with possible complications. This entity can be suggested from plain film evaluation, but cross-sectional imaging with either CT or MR confirms the diagnosis. The characteristic finding is calcification in the superior-most fibers of the longus colli tendons at the C1 - C2 level. Although this usually is visible on C-spine radiograph, CT and MRI clearly define the abnormality and allow evaluation of the surrounding soft tissues. Retropharyngeal edema and/or effusion usually is associated with this disorder; however, the presence of rim-enhancing collection favors a retropharyngeal abscess. The primary goal of imaging is to differentiate retropharyngeal calcific tendinitis from abscess. In the case of calcific tendinitis, a follow-up CT of the neck or lateral radiograph of the C-spine will show resolution of the calcifications with time. The three patients we reviewed presented within 2 weeks of one another and share a similar geographic location. We feel this raises the possibility of a viral or seasonal component to the development of retropharyngeal calcific tendinitis that to the best of our knowledge has not been described in the literature.

SUMMARY/CONCLUSION
Awareness of this disease process and knowledge of the characteristic imaging findings of retropharyngeal calcific tendinitis are necessary in order to prevent possible harmful and unnecessary treatment and intervention. Counseling the patient on the expected course for this disease and treatment with anti-inflammatory medications will help to alleviate the patients’ pain and concern. Although further research is necessary, our patient pool suggests that this entity may develop secondary to a viral or seasonal component.

KEY WORDS: Calcific tendinitis, retropharyngeal abscess
**Scientific Exhibit 54**

**Extradural Spinal Masses of Soft Tissue Origin: Approach to Differential Diagnosis**

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**PURPOSE**

Primary or secondary bone tumors account for a majority of extradural spinal masses encountered in clinical practice. In this review, we share our experience with extradural spinal lesions of soft tissue origin, and classify these lesions based on their primary anatomical origin.

**APPROACH/METHODS**

Radiology data base at a tertiary care center containing studies performed between 2001 and the present was queried for patients with extradural spinal masses. Lesions primarily arising within the bones at the level of the mass, or with the initial imaging diagnosis of disk herniation, were excluded. The remaining lesions were classified based on their anatomical origin within the extradural space.

**FINDINGS/DISCUSSION**

A total of 90 lesions were identified in patients ranging in age from 4 months to 88 years. These included traumatic/iatrogenic (epidural hematoma); infectious (epidural abscess); inflammatory (rheumatoid arthritis, calcium pyrophosphate dehydrate deposition disease, gout); degenerative (synovial cyst, ligamentum flavum cyst); neoplastic (hemangioma, chondroma, meningioma, schwannoma, and extraspinal neoplasms extending across the neural foramina); and miscellaneous (reactive changes in the epidural venous plexus) conditions. A number of diseases typically originating within the bone marrow, including lymphoma, leukemia, hematogenous metastases, and extramedullary hematopoiesis, also were noted to present as epidural soft tissue masses without any associated bony destruction. Extradural soft tissue lesions could be categorized based on their anatomical origin from meninges, epidural fat, vasculature, nerve roots, ligaments, intervertebral disks, facet joints, atlantoaxial articulation, and paraspinal structures.

**SUMMARY/CONCLUSION**

This review illustrates the imaging findings of several extradural soft tissue spinal masses. We present our approach to the differential diagnosis of these lesions, utilizing their anatomical relationship to spinal structures and imaging characteristics.

**KEY WORDS:** Spinal neoplasms

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**Scientific Exhibit 55**

**Spinal Cord Injury: Identifying the Indirect Causes at Imaging**

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**PURPOSE**

Traumatic spinal cord injuries continue to afflict the population with a changing trend that puts the elderly at increased risk. Outcome of treatment depends on clear diagnosis of type of injury and what is responsible for these injuries to the spinal cord. Imaging, particularly MRI delineates not only the type of spinal cord lesions but also presence of indirect causes. This is an educational exhibit detailing the imaging findings and how to make accurate diagnosis in the various forms of indirect injuries to the spinal cord.

**APPROACH/METHODS**

Various forms of indirect causes of spinal cord injuries such as fractures and dislocations, disk herniations, vascular injuries, various forms of ligamental and paraspinal soft tissue injuries, fluid/blood collections etc. will be presented. Subtle findings that are overlooked easily will be highlighted. Selection of appropriate sequences will be discussed. The impact of these findings on outcome of management will be stressed.

**FINDINGS/DISCUSSION**

Using a combination of appropriate imaging modalities makes diagnosis of traumatic spinal cord injury and their various causes less stressful.

**SUMMARY/CONCLUSION**

Teaching points include 1) how to interpret subtle changes in signal intensity pattern, 2) how to utilize various sequences to highlight pathologies, and 3) categorization of stable and unstable injuries and how they affect the spinal cord.

**KEY WORDS:** Spinal cord injury, spinal cord imaging, MRI of spinal cord injury

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**Scientific Exhibit 56**

**Peri-Procedural Imaging for Kyphoplasty: Imaging Characteristics from Selection Criteria to Postprocedural Complications**

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**PURPOSE**

Kyphoplasty recently has become one of the mainstay treatment options for painful acute and subacute vertebral compression fracture. The purpose of this exhibit is to outline the imaging characteristics of these compression fractures on various imaging modalities, to highlight imaging features of compression fractures that are contraindicated for kyphoplasty, to briefly discuss the expected intraprocedural
Scientific Exhibits reveal both normal imaging characteristics and complications postkyphoplasty.

**Approach/Methods**
Vertebral compression fractures, either due to osteoporosis or underlying malignancies, frequently cause severe pain and significantly impair function. Both vertebroplasty and kyphoplasty have proved to stabilize compression fractures and relieve pain. Therefore, it is important for the general radiologists and neuroradiologists to recognize the pre, intra, and postkyphoplasty imaging features on various imaging modalities for proper referral and follow up. We have started recently to perform kyphoplasty in our interventional suite. In this exhibit, we will discuss imaging findings of acute and subacute compression fractures in our patients on conventional radiograph, MR, CT, and nuclear medicine studies, show features of those fractures that should not be referred for kyphoplasty, demonstrate intraprocedural images, and highlight normal postkyphoplasty anatomy and complications of kyphoplasty to look for.

**Findings/Discussion**
Vertebral compression fracture most commonly occurs at midthoracic and thoracolumbar junction. Normal spine anatomy and various forms of compression fractures will be discussed. Acute and subacute compression fractures, both osteoporotic and neoplastic, demonstrate new anterior wedging or progression loss of vertebral body height on conventional radiograph, with edema and enhancement on MR, impaction or fracture line on CT, and increased radiotracer uptake on all three phases of bone scan. Those compression fractures that are not painful, are more than one year old, or demonstrate no increased radiotracer uptake on bone scan and no edema on MR, as well as those that are burst fractures, with significant retropulsed fragments, or have fracture line extending to the posterior vertebral cortex, should not be referred for kyphoplasty. Intraprocedure, vertebral compression fracture can be stabilized with or without significant restoration of vertebral body height. Injection should be stopped at first sign of bone cement extravasation. Immediate postprocedural imaging is not necessary and is not performed routinely. However, follow-up imaging often is performed due to a questionable slight increase in compression fracture rate at adjacent vertebral levels or due to baseline spondylosis and radiolucrepathy. We will discuss the normal appearance of postkyphoplasty spine on various imaging modalities as well as imaging complications such as cement extravasation, pedicle fracture, and adjacent vertebral fractures. Systemic complications also will be discussed.

**Summary/Conclusion**
Since kyphoplasty has become one of the mainstay treatment options for painful vertebral compression fracture, it is important to be familiar with imaging features of acute and subacute vertebral compression fractures that are amenable to kyphoplasty, be aware of characteristics of those that are contraindicated for kyphoplasty treatment, and to recognize postprocedure complications of kyphoplasty in order for proper referral and follow up.

**Key Words:** Kyphoplasty, compression fracture

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**Scientific Exhibit 57**

**Intrathecal Masses of the Lumbar Spine**

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**Purpose**
Evaluation of lumbar spinal masses in clinical practice often presents a diagnostic challenge. Generating a concise differential diagnosis is dependent upon both placement of the mass into the correct extradural or intradural space and knowledge of lesions presenting in each location. In this exhibit, we focus on the diagnosis of intrathecal masses by reviewing the intrathecal spaces of the lumbar spine, illustrating pertinent examples of both common and less common intrathecal masses, and highlighting radiologic teaching points in establishing a diagnosis.

**Approach/Methods**
Anatomy of the conus medullaris, cauda equina and filum terminale, as well as the extraaxial spaces are reviewed. Illustrative examples of intrathecal masses were collected from representative patients presenting to a large tertiary care academic medical center for either initial or follow-up diagnostic imaging. When available, pathologic correlation is provided. Pertinent clinical and imaging characteristics of each entity then are discussed in a pictorial representation.

**Findings/Discussion**
Representative lesions include both benign and malignant entities such as: meningioma, intradural disk herniation, neurofibroma, ependymoma, hemangioblastoma, neurilemoma, epidermoid, drop metastasis, lymphoma, and arachnoid cyst.

**Summary/Conclusion**
Great overlap exists in the clinical presentation of both benign and malignant intrathecal masses. As a result, imaging is essential in providing prompt diagnosis and appropriate clinical management. Thus, an awareness and understanding of the unique imaging characteristics of each entity is necessary in providing effective patient care.

**Key Words:** Intrathecal, spine, neoplasm
Day at the Metropolitan through the Eyes of a Neuroradiologist: Ten Lessons the Great Paintings Teach Us

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PURPOSE
To highlight principles of head CT interpretation through art appreciation. Art history, technique and methods of analysis are discussed. We demonstrate how ways of viewing and understanding paintings enhance neuroradiology skills and lessen the trepidation of the novice.

APPROACH/METHODS
A staff neuroradiologist accompanied by four radiology residents explored the old master European and Impressionist collections at the Metropolitan Museum of Art in New York City. Research tools during this “readout” session included pens, notebooks and a Canon EOS 40D camera, with permission from the museum’s educational department. Selected art reproductions are presented with corresponding MDCT images from our institution to emphasize key concepts in evaluating head CTs.

FINDINGS/DISCUSSION
1) First see the big picture and avoid obsessing over distracting detail. Peter Brueghel’s “The Harvesters” reflects an entire society at work, including distant ships sailing for foreign ports, which is not fully appreciated if one focuses solely on the peasants in the foreground. Fixation on a cerebral hemorrhage may detract from a more emergent finding, herniation. 2) Next pay attention to subtle complexities. Bosch’s “Descent into Hell”, upon close inspection, reveals minute nightmarish figures, ideally examined at leisure with a magnifying glass. Glioblastoma multiforme may be immediately apparent; however, the detection of satellite lesions adds another dimension to the case. 3) Be alert to asymmetry. In Degas’ “A Woman Seated Beside a Vase of Flowers”, we feel unsettled by the compositional imbalance. Ventricular asymmetry suggests underlying abnormalities. 4) Use contrast differences to your advantage. Caravaggio employed stark shadows to emphasize drama in “The Denial of Saint Peter”. Varying CT windows can detect subtle infarcts and bleeds. 5) Recognize lack of detail and sharpness. Monet’s “The Houses of Parliament (Effect of Fog)” dissolves into light. Loss of gray-white differentiation may indicate cerebral edema or stroke. 6) Note classic appearances. The swirling forms in Van Gogh's “Cypresses” are typical of his brushwork. Colloid cyst and neurocysticercosis are “Aunt Minnies” for neuroradiologists. 7) Note groupings of like objects. Each of Cezanne’s “Apples” is unique yet forms part of a formal group. Thalamic, posterior temporal and occipital hypodensities collectively indicate posterior cerebral artery infarction. 8) Do not ignore the periphery. In Goya’s “Don Manuel”, a child holds a bird on a string. In the shadows three cats stare menacingly, imparting a sinister effect. Subtle extraaxial hemorrhages are overlooked easily. 9) Know important associations and where to redirect focus. Pisarro channels our gaze with leading lines in “Boulevard Montmartre”. Occipital confusion with scalp hematoma shifts us to the frontal lobes for contre-coup injury. 10) Contextualize the findings. Though initial impressions are important, consider the historical backdrop. David’s “Death of Socrates” depicts stoic acceptance of fate and also reflects the philosophy and mores of the artist’s time. Clinical history is essential in forming a meaningful differential diagnosis.

SUMMARY/CONCLUSION
A CT scan, like a painting, is a compelling visual narrative with multiple levels of complexity. In viewing great art, parallels can be made to our approach in interpreting head CTs, increasing our appreciation of both.

KEY WORDS: Art, head CT
Electronic Scientific Exhibit 2
Susceptibility-Weighted Imaging: Clinical Role in Venous Thrombosis and Venous Congestion at 1.5T

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PURPOSE
Susceptibility-weighted imaging (SWI) exploits phase shift itself to enhance contrast caused by the susceptibility differences between tissues, and creates contrast between deoxygenated veins and the neighboring tissue in the brain. We present two patients with acute venous thrombosis and dural arteriovenous fistula (dAVF), and investigate clinical roles of SWI in venous thrombosis and venous congestion.

APPROACH/METHODS
MR examinations were performed with a clinical imager operating at 1.5T. Susceptibility-weighted images were acquired with a three-dimensional (3D) fast low-angle shot (FLASH) sequence with a TE of 40 ms, a low bandwidth (80 Hz/pixel), a fully, first-order, velocity-compensated gradient moment nulling in all three orthogonal directions, 72 partitions, a voxel volume of 0.8 x 0.7 x 1.6 mm and the coverage volume was 115 mm thick. The total acquisition time was 6 minutes and 19 seconds using parallel imaging technique.

FINDINGS/DISCUSSION
Case 1. A 57-year-old man presented with sudden-onset psychiatric disorder and confusion. Emergency MRI showed hyperintense lesions in the left frontal cortex on FLAIR and DWI with no decrease in ADC. Susceptibility-weighted imaging demonstrated tortuous draining veins with marked hypointensity in the left frontal lobe, with microbleeds (fig.). Those SWI findings suggested venous congestion caused by acute venous thrombosis in the dural sinus. Postcontrast 3D T1WI and 2D-PC MRA confirmed acute thrombotic occlusion in the superior sagittal sinus. CE-MRA confirmed acute thrombotic occlusion in the dural sinus. Postcontrast 3D T1WI and 2D-PC MRA confirmed acute thrombotic occlusion in the superior sagittal sinus. Case 2. A 83-year-old woman admitted with pulsation tinnitus in the left temporo-occipital region. Diffusion-weighted imaging and T2WI show a negative finding. Susceptibility-weighted imaging showed markedly tortuous cortical veins with significant hypointensity in the left temporal and occipital lobes, compared to the contralateral hemisphere. Combination of clinical and SWI findings suggests venous stasis and reflux caused by dAVF. Digital subtraction angiography confirmed dAVF secondary to chronic sinuses thrombosis.

SUMMARY/CONCLUSION
Clinical diagnoses of venous thrombosis and venous congestion are often elusive, because neurologic symptoms are usually nonspecific. MR signal from thrombus can mimic normal flow void or flow enhancement. Up to 50% may progress to cerebral swelling, venous infarction and hemorrhage. Susceptibility-weighted imaging directly demonstrates venous stasis and reflux due to elevation of venous pressure caused by venous drainage obstruction or dAVF. Susceptibility-weighted imaging also detects acute clot formation in the dural sinus. In conclusion, SWI has the possibility to diagnose acute venous thrombosis and dAVF, prior to lethal complications.

KEY WORDS: Susceptibility-weighted imaging, Venous thrombosis, dural arteriovenous fistula

Electronic Scientific Exhibit 3
Carotid Plaque Imaging: MR Protocol and Novel Imaging Techniques

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PURPOSE
Atherosclerotic plaque in the carotid arteries is one of vulnerable risk factors of cerebral ischemic stroke. Rupture of lipid-rich plaque may cause fibrin-rich thrombus formation and artery-to-artery embolic occlusion of intracranial cerebral arteries. Double inversion recovery, dark blood imaging (DB) sequences with cardiac gating are considered as the gold standard for MR plaque imaging; however, a single-slice DB sequence takes a long acquisition time. BLADE (PROPELLER; periodically rotated overlapping parallel lines with enhanced reconstruction) is a self-navigating...
method for motion correction by repeated data acquisition of the center of k-space. BLADE reduces motion artifact arising from physiologic respiratory movement, arterial pulsation and swallowing. BLADE provides clear cervical anatomical contour and lesion conspicuity. This study was performed to estimate clinical utilities of BLADE technique for the detection and evaluation of carotid plaque in ischemic stroke patients.

**APPROACH/METHODS**
All patients were examined at 1.5T MR system using 4-channel neck coil. DB T2WI and T1WI with Cartesian k-space trajectory as a gold standard in all patients with ischemic stroke events. multislice BLADE T2WI and T1WI with rotated overlapping sampling were performed in 66 vessels of 33 patients. Single-slice BLADE-DB T2WI and T1WI with cardiac gating and rotated overlapping sampling were done in 23 vessels of 14 patients. DB T2WI parameters were as follows: 2 R-R/82 ms/17 (TR/TE/ETL); field of view, 16 cm; matrix size, 320; axial sections, 4 mm thick; and scan time, 2 minutes 30 seconds. BLADE T2WI parameters; 3000/78 ms/11; field of view, 16 cm; matrix size, 256; axial sections, 4 mm thick; and scan time, 3 minutes 5 seconds. BLAD DB T2WI; 2 R-R/78 ms/17; field of view, 16 cm; matrix size, 256; axial sections, 4 mm thick; and scan time, 2 minutes 30 seconds.

**FINDINGS/DISCUSSION**
Multislice BLADE sequences detected carotid plaque in all vessels. BLADE showed excellent image quality without significant artifacts. No pseudonegative cases were identified, however, BLADE tended to overestimate the evidence and the size of plaque in 29%, because BLADE corrected slow turbulent flow close to carotid wall. The overall image quality of BLADE-DB T2WI was rated higher in 48% and equal in 43% compared with DB sequences.

**SUMMARY/CONCLUSION**
BLADE T2WI and T1WI are feasible for detecting not only atherosclerotic plaque but also the neighboring turbulent flow, which is a risk factor of the intimal injury. Multislice BLADE sequences are useful methods and the initial sequences of choice for screening of carotid plaque and its risk factor, because those can cover the entire carotid bifurcation without cardiac gating during the same acquisition time as single-slice DB imaging. BLADE DB sequences with cardiac gating are the most preferred methods for precise evaluation of anatomical details and plaque contents. When multislice BLADE T2WI and T1WI show positive findings, single-slice BLADE-DB sequences with cardiac gating should be added to access cardiac plaque precisely.

**KEY WORDS:** Carotid artery, atheromatous plaque, MRI

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**Electronic Scientific Exhibit 4**

**Transient Cytotoxic Edema and Delayed Ischemic Neuronal Injury after Early Reperfusion**

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**PURPOSE**
We present two patients with transient cytotoxic edema and delayed neuronal injury after prompt recanalization of acute arterial occlusion. Those patients showed thrombolytic reversal of bright signal on diffusion-weighted imaging (DWI) and a restoration of apparent diffusion coefficient (ADC) normal immediately after early reperfusion; however, the initial lesions subsequently developed irreversible infarction by the second hospital day.

**APPROACH/METHODS**
The two patients met inclusion criteria of intravenous t-PA thrombolysis, pre and postthrombolytic MR studies. We performed MR studies using a 1.5T unit on an emergency basis. An effective b-value of 1000 was used for diffusion imaging.

**FINDINGS/DISCUSSION**
Case 1: A 46-year-old woman presented with sudden-onset right hemiparesis and total aphasia. The initial MR carried out 80 minutes after onset showed embolic occlusion in the M1 portion of the left middle cerebral artery (MCA) and DWI high signal with marked reduction of rCBF in the territory fed by the left lateral striate arteries (LSA). The patient improved well immediately after intravenous t-PA thrombolysis. Arterial recanalization was confirmed on the postthrombolytic MR 7 hours after onset, and diffusion abnormality was reversed completely. But the initial LSA lesion finally evolved into irreversible infarcted tissue on the third MRI at the second hospital day. Case 2: A 75-year-old woman was admitted with sudden onset left hemiparesis. The initial MRI obtained 70 minutes after onset showed complete occlusion in the M1 portion of the left MCA and DWI high signal with decreased rCBF in the territory fed by the right LSA and the MCA upper trunk. The DWI bright signal was reversed after early reperfusion by intravenous t-PA thrombolysis; however, the initial lesion subsequently evolved into irreversible infarcted tissue.

**SUMMARY/CONCLUSION**
Almost high signal lesions on DWI represent infarcted tissue in hyperacute ischemic stroke; however, DWI reversibility has been demonstrated occasionally after early reperfusion and correlates with neurologic improvement. In our series, the initial cytotoxic edema was transient with ADC normalization in spite of markedly reduced rCBF, but the initial lesions subsequently progressed into irreversible infarcted tissue. Early reversible cytotoxic edema may reflect mild redistribution of water from extracellular space to intracellular space caused by transient membraneous dysfunction. Delayed neuronal injury after transient DWI normalization may reflect increased volume and viscosity of intracellular water due to irreversible damage of membranes and cell organelles induced by various intracellular ischemic cascade mechanisms. Diffusion-weighted imaging reversibility depends not only upon duration of ischemia but also vascu-
lar reserve (i.e., rCBV and rCBV); therefore, cerebral perfusion study should be necessary for estimation of reversibility of diffusion abnormality in early cerebral ischemia.

**KEY WORDS:** Early cerebral ischemia, diffusion imaging, delayed neuronal injury

**Electronic Scientific Exhibit 5**

**Spectrum of Symmetric Cytotoxic Edema in the Corpus Callosum with or without White Matter Involvement: Central Nervous System Cytokinopathy?**

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**PURPOSE**

Symmetric cytotoxic edema in the corpus callosum with or without white matter involvement is associated with various diseases and conditions. Pathogenesis of these conditions remains unknown. However, recent literatures suggest the important role of pro-inflammatory cytokines (TNF-α, interleukine-1β, -γ etc.).

**APPROACH/METHODS**

We reviewed 34 patients with symmetric involvement of the corpus callosum with or without white matter involvement, including epileptic patients with or without antiepileptic drugs, other medications (chemotherapeutic agents), viral (rotavirus, Epstein-Barr virus, influenza virus) or bacterial encephalitis/encephalopathy, cerebral malaria, other encephalopathy (PRES, HIV), osmotic myelinolysis, hemolytic uremic syndrome, malignant diffuse meningeal pathology, and diffuse axonal injury. Imaging modalities include CT, conventional MRI, and diffusion-weighted (DWI) and tensor imaging.

**FINDINGS/DISCUSSION**

The distribution of symmetric cytotoxic edema on DWI in the corpus callosum was categorized into three groups: 1) a small round or oval lesion located in the center of the splenium; 2) lesions extending through callosal fibers laterally in the splenium with or without diffuse white matter involvement; and 3) lesions extending into the anterior corpus with diffuse white matter involvement. Fractional anisotropy was relatively preserved in the cytotoxic edema. Diffuse white matter involvement was associated with severe clinical symptoms and poor prognosis, which were seen in rotavirus encephalopathy, cerebral malaria, Epstein-Barr virus associated hemophagocytic syndrome characterized by hypercytokinemia, and diffuse axonal injury. Recent literatures suggest a multifactorial influence among cytokines, epilepsy and antiepileptic drugs. Increased cytokines in the cerebrospinal fluid (CSF) are observed as an inflammatory response to infection in bacterial or viral meningoencephalitis. CD8 T cell mediated microvascular endothelial damage and leakage of cytokines are postulated as an immunopathogenesis in cerebral malaria. Osmotic demyelination is related to the production of cytokines by microglia. TNF-α induces primary demyelination and oligodendrocyte apoptosis in diffuse axonal injury.

**SUMMARY/CONCLUSION**

Imaging findings of symmetric callosal cytotoxic edema with emphasis on DWI were presented. “CNS cytokinopathy” is considered as an important pathogenesis.

**KEY WORDS:** CNS cytokinopathy, diffusion-weighted, corpus callosum

**Electronic Scientific Exhibit 6**

**Virtual Intravascular MR Endoscopic Evaluation of Cerebral Aneurysm**

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Samsun, TURKEY

**PURPOSE**

Correct determination of the morphology, exact size and inside of the aneurysm, and its relation to the parent artery, increases the success of the treatment by either surgery or endovascular. In this study, we sought the value of the virtual intravascular endoscopy in the evaluation of the aneurysm.

**APPROACH/METHODS**

Sixteen channel multidetector CT angiography (CTA) and MR angiography (MRA) examinations were performed in the patients who suspected with cerebral aneurysm. Virtual intravascular MR endoscopy technique was used on MRA maximum intensity projection (MIP) images. We evaluated the size of the neck and the sac; if it includes the thrombus and inside character of aneurysm by watching within the vessel.

**FINDINGS/DISCUSSION**

The present study included 30 patients with 37 aneurysms. There is no significant difference with CTA and MRA about the number, location, size and neck shape of aneurysms. Virtual intravascular MR endoscopy demonstrated a thrombus in 10 aneurysms, whereas CTA depicted a thrombus in only one which was a giant aneurysm. It was demonstrated that a focal discontinuity at posteromedial wall in a patient who had a posterior communicating artery aneurysm.

**SUMMARY/CONCLUSION**

With intravascular virtual MR endoscopy, we are able to move in slim vessels and little cerebral aneurysms in sizes of 1-2 mm diameter, therefore the aneurysm’s relation in parent artery, neck and inside of sac can be evaluated easily. Virtual intravascular MR endoscopy is an easy and reliable technique with which to performed MRA MIP images.

**REFERENCES**


**KEY WORDS:** Virtual endoscopy, MR angiography, cerebral aneurysm

**Electronic Scientific Exhibit 7**

**Sixty-Four Slice CT Angiography Atlas of Intracranial Neurovascular Pathologies**

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**PURPOSE**
The aims of this exhibits are: 1) To illustrate CT angiography findings of various neurovascular pathologies; and 2) To understand advantages and pitfalls of CT angiography in different neurovascular pathologies.

**APPROACH/METHODS**
Seventy-six patients were referred to our department for CTA between January 2007 and November 2007 for various neurovascular related problems. CT angiography was performed on a 64-slice multislice system. Scan coverage ranged between aortic arch and distal to the circle of Willis. Nonenhanced helical scan (80 kv) and contrast-enhanced helical scan (120 kv) were performed at the same region for bone removal. The data were transferred to a workstation and images were produced using MIP, MPR, SSD and volume rendering. Volume subtraction was done to get bone-free excellent images especially for skull base pathologies. In a few cases venous phase also was obtained in addition to arterial phase. CT angiography appearances in different pathologies are described and illustrated.

**FINDINGS/DISCUSSION**
CT angiography nicely demonstrated the neurovascular pathologies in most of cases. MIP was the primary tool to look at vessels; however, 3D volumetric imaging was crucial for better understanding of complex anatomical relations. Bone-free images were helpful for evaluation of small aneurysm at skull base. In all operated cases excellent correlation was obtained.

**SUMMARY/CONCLUSION**
Accurate delineation of neurovascular architecture is extremely important in presurgical planning. CT angiography is a noninvasive powerful tool and is becoming the primary imaging modality for evaluation of neurovascular pathologies. This exhibit will facilitate correct interpretation of CTA for different neurovascular pathologies.

**KEY WORDS:** CTA, neurovascular

**Electronic Scientific Exhibit 8**

**Caught in the Middle: The Radiologic Spectrum of Meningeal Disease**

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**PURPOSE**
To review the broad spectrum of diseases of the meninges and their complications. We present a comprehensive anatomically-based radiologic approach to this complex multilayered system. Lesions are categorized according to both location (leptomeningeal, pachymeningeal, or both) and etiology. Extrameningeal invaders and mimics also are discussed.

**APPROACH/METHODS**
We retrospectively reviewed all imaging studies (CT, MR, and angiography) of patients with meningeal lesions presenting during the past 10 years at our institution. We categorized these entities as infectious, inflammatory, neoplastic, congenital, vascular, and traumatic etiologies.

**FINDINGS/DISCUSSION**
Infections of the meninges can be viral, bacterial, or parasitic. A leptomeningeal pattern of enhancement is seen with viral and bacterial sources. In such cases, the brain parenchyma also should be inspected carefully for subtle enhancement indicative of meningoencephalitis. Neurocysticercosis can present as a racemose form, resembling a cluster of grapes, or as a basal arachnoiditis. Granulomatous diseases include sarcoidosis, a great imitator, eosinophilic granuloma and tuberculosis. Adverse sequelae include hydrocephalus, ventriculitis, cerebritis/abscess, empyema and venous sinus thrombosis. An inflammatory chemical meningitis can result from a ruptured dermoid. Neoplasms can be divided into those of meningothelial cell origin (meningioma and its atypical variants), nonmeningothelial mesenchymal entities (fatty, fibrous, vascular, chondroid or muscular stroma) and melanocytic lesions. Hemangiopericytoma, a large lobulated sarcoma, may be differentiated from meningioma by its heterogeneity and lack of calcification or hyperostosis. Neoplasms, primary cerebral and metastatic (e.g., breast carcinoma), can involve both the leptomeninges and pachymeninges. A pachymeningeal pattern favors carcinomatous over infectious meningitis. Lymphoma and leukemia commonly involve the dura. Congenital abnormalities include arachnoid cysts and encephaloceles/meningoceles. Both cephaloceles and posttraumatic leptomeningeal cysts are associated with calvarial defects. Dense, thick dural calcifications may be seen with basal cell nevus syndrome as well as renal osteodystrophy. Noncalcific iatrogenic dural thickening can result from intracranial hypotension or postsurgical fibrosis. Vascular processes include Sturge-Weber (encephalotrigeminal angiomatisos) and superficial sidersis. Extrameningeal invaders, in addition to the parenchymal neoplasms already mentioned, also can include scalp or calvarial lesions, such as multiple myeloma. Postinfarct gyri-form enhancement should not be misinterpreted as leptomeningeal disease.
**SUMMARY/CONCLUSION**
The evaluation of meningeal disease requires consideration of enhancement patterns and location. The radiologist should be alerted especially to surrounding pathology, which can provide important clues to significantly narrow the differential diagnosis.

**KEY WORDS:** Meninges

**Electronic Scientific Exhibit 9**

Clinical Utility of Time-Resolved MRA in the Diagnosis of Intracranial and Extracranial (Head and Neck) Pathology

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**PURPOSE**
Time-resolved MRA is a noninvasive technique whereby multiple phases of a first pass injection of gadolinium contrast agent are imaged. This information can be postprocessed to provide multiplanar and 3D data sets which allows better assessment of anatomical abnormalities. Time-resolved MRA is useful for depicting various vascular lesions in the brain, spinal cord and head and neck, including vascular malformations, arterial stenosis and dissection, aneurysms, as well as vascular tumors.

**APPROACH/METHODS**
Time-resolved MRA was performed using 3D time-resolved imaging of contrast kinetics (3D TRICKS) protocol, which employs multiphase first pass imaging with precontrast digital subtraction in the coronal or axial plane. For cervical studies, 320 x 224 matrix was employed with 1.8 mm slice thickness and a 30 cm field of view. Coronal MIP and postprocessed 3D reformatted images were obtained from this initial data set. For brain studies, a square 256 x 256 matrix was employed with a 1.6 cm slice thickness and a 22 cm field of view. Axial MIP and postprocessed 3D reformatted images were obtained from this initial data set. Reformatted data sets were superimposed over corresponding MR images of the lesion of interest. Comparison was made to other modalities, including digital subtraction angiography (DSA), CT angiography (CTA), as well as noncontrast time of flight (TOF) MRA and standard contrast-enhanced MRA. We examined common pathologies of the brain and head and neck including vascular tumors, craniofacial vascular anomalies, hemangiomas, vascular malformations, arteriovenous malformation, venous malformation, lymphangioma, cavernous hemangioma, lymphangiohemangioma, macrocystic lymphatic malformation, arteriovenous fistula.

**FINDINGS/DISCUSSION**
Time-resolved MRA demonstrates better signal to noise than noncontrast TOF MRA, and provides temporal resolution that TOF MRA, conventional contrast-enhanced MRA and single-phase CTA cannot provide. Time-resolved MRA is a much faster acquisition than TOF MRA and conventional contrast-enhanced MRA. Time-resolved MRA obviates the need for a timing bolus, which further reduces scanning time, makes the sequence less operator dependent reduces venous contamination and the need for bolus timing. Time-resolved MRA can demonstrate flow dynamics such as late filling and early draining veins that conventional cross-sectional vascular imaging cannot. In addition, TR MRA allows comparison of enhancement rates between cervical vessels, something that is very difficult to assess with DSA, TOF MRA, or CTA. Time-resolved MRA is less invasive than DSA, and provides information about 3D anatomy from a single postprocessed data set that may require multiple series in different projections using DSA. Time-resolved MRA data sets may be fused with conventional MR images to depict precise anatomical locations and relationships which may aid in therapeutic planning. These characteristics make TR MRA a useful noninvasive modality for investigating a variety of vascular lesions.

**SUMMARY/CONCLUSION**
Time-resolved MRA is a useful technique for examining various vascular lesions in the neuroaxis and head and neck, with features that compliment conventional cross-sectional imaging as well as DSA. Unique information about anatomical relationships and precise locations of lesions, as well as the temporal resolution is able to increase our diagnostic confidence.

**KEY WORDS:** Time-resolved MRA, TRICKS, vascular lesions

**Electronic Scientific Exhibit 10**

Trigeminal Neuralgia: Pathophysiology, MR Imaging and Current Treatment

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**PURPOSE**
Describe the clinical manifestations and pathophysiology of trigeminal neuralgia. Review the normal anatomy and the common pathologic conditions affecting the trigeminal nerve. Indicate a MRI protocol for evaluating trigeminal neuropathy, and present an overview of management and treatment of trigeminal neuralgia.

**APPROACH/METHODS**
Selection of trigeminal lesions among encephalic MRI exploring trigeminal neuralgia in our institution between 2002 and 2007. We correlated imaging findings with clinical outcome and pathology. Patients were examined using a 1.5T MRI. Imaging protocol included sagittal T1-weighted MR, axial T2-weighted MR, nonenhanced 3D inframillimetric T2-weighted MR imaging, axial T1-weighted MR contrast-enhanced with and without fat saturation.

**FINDINGS/DISCUSSION**
The most common pathologic conditions affecting the trigeminal nerve were discussed in relation to their locations and in terms of the MR imaging techniques most appropriate for their evaluation.
Lesions were malformative, vascular, inflammatory, tumoral or posttraumatic and were located in the full course of the trigeminal nerve, from its nuclei in the brain stem to its extracranial branches.

**SUMMARY/CONCLUSION**
Because the clinical findings in patients with trigeminal neuropathy do not permit accurate lesion localization, the entire course of the trigeminal nerve should be evaluated on MR imaging studies. We reviewed the most common lesions involving the trigeminal nerve. We present a MRI protocol for evaluating each segment, and introduce an overview of the treatment of trigeminal neuralgia.

**KEY WORDS:** Trigeminal neuralgia, pictorial, treatment

**Electronic Scientific Exhibit 11**
**Demonstration of the Cerebral Reorganization in Diabetic Patients after Lower Limb Amputation by Using Functional MR Imaging**

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**PURPOSE**
The aim of this study is to detect sensorymotor changes in cranio-neural system with functional MRI (fMRI) in diabetic patients who had lower limb amputations due to peripheral neuropathy.

**APPROACH/METHODS**
Eleven diabetic subjects who had lower limb amputations due to peripheral neuropathy (group I), three diabetic subjects who did not have limb amputation, diabetic wound or ulcer (group II) and one healthy subject were evaluated radiologically and clinically. Dynamic fMRI examinations were performed in 8 sections as 4 intervals. Each interval had 30 seconds of activity and 30 seconds of resting periods.

**FINDINGS/DISCUSSION**
Functional MRI results of amputated lower limb stumps of diabetic patients were compared with fMRI results of non-amputated lower limbs of diabetic patients. Also, fMRI results of all subjects were compared with the fMRI results of healthy subject. Functional MRI results of amputated lower limb subjects were compared with fMRI results of the subjects’ opposite limb. Functional MRI results of amputated lower limbs during movement had decreased cortical activation when compared with nonamputated lower limbs as a result of cerebral cortical reorganization. Functional MRI results of diabetic patients had decreased cortical activation when compared with the healthy subject. We have determined cerebral cortical reorganization in diabetic patients’ cranio-neural system which is a consequence of chronically decreased afferentiation due to decreased or no sensorial conduction. Also, cortical activation values of fMRI in non-amputated lower limbs were lower when compared with the healthy subject.

**SUMMARY/CONCLUSION**
These results show that in diabetic patients decreased afferentiation process starts earlier than amputation and diverge from acute deafferentiation reorganization due to traumatic amputation or nerve injury.

**KEY WORDS:** fMRI, cerebral cortical reorganization

**Electronic Scientific Exhibit 12**
**Validation of a Multiparametric Algorithmic Approach in the Characterization of Intraaxial Brain Masses with Multicenter Data**

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¹Mount Sinai Medical Center, New York, NY, ²New York University Medical Center, New York, NY, ³Universidade Federal de Pernambuco, Recife, BRAZIL, ⁴Hospital Albert Sabin, Recife, BRAZIL

**PURPOSE**
The purpose of this study is to investigate and validate a multiparametric algorithmic approach in the characterization intraaxial brain masses using MRI diffusion, perfusion MR and MR spectroscopy.

**APPROACH/METHODS**
 Thirty-six patients with an intraaxial mass lesion who had undergone conventional and advanced MRI from multiple centers were reviewed. We investigated an algorithmic strategy previously published (1) to classify intraaxial masses as low grade gliomas, high grade gliomas, metastases, abscesses and lymphomas. We estimated the 95% confidence interval (CI) for the overall accuracy, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) observed at each node corresponding to each question (Fig 1). Each confidence interval was derived using the Blyth-Still-Casella procedure.

**FINDINGS/DISCUSSION**
The accuracy, sensitivity and positive predictive values for each corresponding node are as follows (Fig 1): Q1 - Is there contrast enhancement? 91.4% (32/35), 94.1% (32/34), 97.0% (32/33); Q2 - Is the ADC > 1.17? (20/23), 87.0% (20/23), 100% (20/20); Q3 - Is there rim enhancement? 100% (4/4), 100% (4/4), 100% (4/4); Q4 - Is the rCBV > 1.75? (and ADC > 1.1 and contrast enhancement) 73.7% (14/19), 82.4% (14/17), 87.5% (14/16); Q5 - Is the perilesional Cho/NAA > 2.2? (and contrast enhancement and ADC > 1.1 and rCBV > 1.75) 70.6% (12/17), 75.0% (12/16), 92.3% (12/13); Q6 - Is the rCBV > 1.75? (and rim enhancement and ADC > 1.1 and contrast enhancement) 100% (3/3), 100% (3/3), 100% (3/3); Q7 - Is the Cho/NAA > 2.2? (and no contrast enhancement) 36.6% (7/11), 77.8% (7/9), 77.8% (7/9); Q8 - Is the rCBV > 1.75? (and Cho/NAA > 2.2 and no contrast enhancement) 80.0% (4/5), 100% (4/4), 80.0% (4/5). The number of true positive (TP), true negative (TN), false negative (FN) and false positive (FP) results observed at the node corresponding to each question are provided in Table 1.
Table 1. The number of true positive (TP), true negative (TN), false negative (FN) and false positive (FP)

<table>
<thead>
<tr>
<th>Question</th>
<th>TP</th>
<th>TN</th>
<th>FN</th>
<th>FP</th>
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<td>0</td>
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<td>12</td>
<td>0</td>
<td>4</td>
<td>1</td>
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SUMMARY/CONCLUSION
An integrated, algorithmic MR imaging strategy is accurate in differentiating several different pathologies in the brain. This can be validated independently with multicenter MRI, diffusion, perfusion MR and MR spectroscopy.

REFERENCES

KEY WORDS: Brain masses, algorithmic, advanced MRI

Electronic Scientific Exhibit 13
Importance of T2*-Weighted Gradient-Echo Imaging in Neuroradiology and Its Pitfalls: A Pictorial Review
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PURPOSE
Gradient echo [Gradient Recalled Echo (GRE)] imaging has become a part of routine sequences in imaging of the brain. Though this is mainly used to detect hemorrhage, other diagnostic information is available from this sequence. We describe a short explanation of the physics, different acquisition techniques and clinical examples of brain and spine imaging and some pitfalls in this review.

APPROACH/METHODS
We review our case records to show the use of (simple) GRE images for diagnosis of a multitude of neurologic diagnoses. Advance MR imaging techniques like fast imaging techniques, fMRI uses some form of GRE imaging, but these are not described here.

FINDINGS/DISCUSSION
We start with a short explanation of physics and how it influences the imaging characteristics. A detailed explanation of different stages of hemorrhage evolution with corresponding T1 imaging is described. Examples of other conditions including microbleed, DAI, intraarterial clot, venous thrombus, hemorrhagic infarct, cavernoma, capillary telangiectasia and superficial siderosis are shown. We have shown cases of multiple system atrophy, neurocysticercosis, spinal cord hemorrhagic infarct. Improved beneficial resolution of 3T scanner is seen in a patient with vasculitis. Some pitfalls including use of fat suppression technique are shown.

SUMMARY/CONCLUSION
In our review, role of simple GRE imaging in daily practice of neuroradiology is described beyond only the detection of hemorrhage. We have shown examples of pitfalls that one should also keep in mind.

KEY WORDS: GRE imaging, brain and spinal cord, pictorial review

Electronic Scientific Exhibit 14
Imaging Gallery of Seizure: A Compilation of Diverse and Unusual Cases
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East Meadow, NY

PURPOSE
To illustrate and review the broad spectrum of intracranial diseases that can produce seizures. We discuss pertinent anatomy and imaging protocols and also emphasize the importance of clinical presentation. The goals of the radiologic workup in guiding medical and surgical management are explored.

APPROACH/METHODS
We retrospectively reviewed the imaging studies of patients with seizures who presented through our seizure clinic or through the emergency department at our Level I Trauma Center during the past 5 years. Modalities included MDCT (with 2D and 3D reconstructions), CTA, MRI (including DWI, MRA and MRV) and SPECT. We categorized pathologies according to etiology and also considered additional factors such as patient age, temporal course and seizure subtype.

FINDINGS/DISCUSSION
Developmental malformations are seen most commonly in patients below 2 years of age. Abnormalities of neuronal migration and cortical organization include lissencaphaly, heterotopia (nodular and band-like), focal cortical dysplasia, schizencephaly, polymicrogyria and unilateral hemimegencephaly. An unusual case of hypothalamic hamartoma, associ-
ated with Pallister-Hall syndrome is presented. Phakomatoses associated with seizure are most commonly tuberous sclerosis and Sturge-Weber syndrome. The vascular category includes intractable seizures. Mesial temporal sclerosis, a common variety to be operable and can be identified best on coronal images. Incidental normal variants in the temporal lobes that may be detected during workup and are not to be mistaken for seizure-related pathology include choroidal fissure and hippocampal cysts and hippocampal sulcus remnants.

**Summary/Conclusion**
The diversity of lesions producing seizures is immense. The radiologist can play a crucial role in the management of these patients by offering a concise differential diagnosis based upon knowledge of key distinguishing imaging features as well as an appreciation of clinical presentation.

**Key Words:** Seizure imaging

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**Electronic Scientific Exhibit 15**

**Atypical MR Imaging Findings of Medulloblastomas**

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**Purpose**
Medulloblastoma is the most common pediatric central nervous system malignancy and the most common primary tumor of the posterior fossa in children. The imaging features of medulloblastomas are well known; however, variances from these classical imaging findings are common. The purpose of this exhibit is to present a spectrum of MR findings in medulloblastomas especially focusing on atypical appearances and different cystic patterns in subtypes.

**Approach/Methods**
We retrospectively reviewed MR images of 24 patients who had a pathologic diagnosis of medulloblastoma. Pathologic diagnoses consisted of classic subtype in 15, anaplastic in five, and desmoplastic in four patients.

**Findings/Discussion**
The study group consisted of 12 female and 12 male patients. The median age was 7.6 years ranging from 1 to 23 years. Cyst formation (75% of all cases) were more common in classical subtype (54%) and less common in anaplastic (12.5%) and desmoplastic subtypes (8.3%). Other less common features included nodular enlargement of the cerebellar folia in a striated pattern resembling Lhermitte-Duclos disease, nodularity and ill-defined margins.

**Summary/Conclusion**
Atypical MR imaging features of pediatric medulloblastomas are presented with emphasis on cystic components and imaging correlates of desmoplastic and anaplastic subtypes.

**Key Words:** Medulloblastoma, MRI

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**Electronic Scientific Exhibit 16**

**Morphologic and Functional Neuroimaging in Temporal Lobe Epilepsy**

Malhotra, A. · Mangla, R. · Kumar, V. · Kolar, B. · Westesson, P.
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**Purpose**
The purpose of this exhibit is to illustrate the different causes of temporal lobe epilepsy (TLE) and the role of neuroimaging in the evaluation of these patients.

**Approach/Methods**
Temporal lobe epilepsies are a group of medical disorders in which humans and animals experience recurrent epileptic seizures arising from one or both temporal lobes of the brain. The causes or etiology of different TLEs vary. Imaging plays a critical role in the pre and postoperative management of patients with this condition. MRI has gained more and more importance in the evaluation of patients with TLE. We will briefly review the normal anatomy of the temporal lobes, discuss the common causes of TLE and their imaging appearances.

**Findings/Discussion**
The most common cause of TLE is hippocampal sclerosis. Until recently, hippocampal sclerosis could not be identified reliably. Using optimized MRI techniques, hippocampal sclerosis now can be evidenced in a large proportion of patients with TLE. Tumors, developmental abnormalities, vascular malformations, and traumatic scars represent the other structural lesions associated with TLE. Specific MR sequences increase the diagnostic value of MRI (coronal images perpendicular to the axis of the hippocampal formations, three-dimensional T1-weighted images, inversion recovery images, volumetry or more specific processes such as T1 and T2 relaxometry or spectroscopy). MRI also helps guide placement of intracerebral and subdural electrodes in surgically relevant cases. All these results have given greater importance to MRI in the definition of the epileptic syndrome of TLE.

**Summary/Conclusion**
Radiologic diagnostic procedures are essential for the diagnosis and treatment planning of patients with temporal lobe epilepsy. Radiologists need to be confident about interpretation of these imaging in these patients. This exhibit will provide the practicing radiologists an opportunity to become familiar with their imaging characteristics.

**Key Words:** Epilepsy, temporal lobe, imaging
Electronic Scientific Exhibit 17

Pitfalls and Artifacts in Dynamic Susceptibility Contrast MR Perfusion of Brain

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Rochester, NY

PURPOSE
The dynamic susceptibility contrast imaging of brain has been established as a clinically useful tool. There are many pitfalls and artifacts associated with dynamic susceptibility contrast (DSC) imaging. They can be varied from various parameters in acquiring the sequence, calculation of maps and choosing arterial input function. All of these can lead to error in measurement of cerebral blood volume (CBV), cerebral blood flow (CBF), mean transit time (MTT), permeability and blood-brain barrier (BBB) leakage. In addition there are many artifacts within the finally acquired maps which can masquerade as lesions and many times decrease the utility of the examination.

APPROACH/METHODS
We have reviewed our DSC perfusion images from 2003 to 2007 with particular attention to the artifacts. We would like to describe them in this exhibit. We also would describe various pitfalls in the DSC imaging. We analyze and classify all these aspects, to allow the technician and the radiologist to know exactly what to avoid and what to choose, and we indicate when possible the way to improve the quality of examination.

FINDINGS/DISCUSSION
The various issues related to artifacts from blood, bone, metal, melanin and calcification have been discussed. Various venous angioma and other normal vessels can cause confounding in CBV. We also discuss the BBB leakage correction and T1 permeability in the DSC imaging. Besides this the issue of internal reference in generation of color maps is discussed. There are many issues regarding size of region of interest (ROI) while taking rCBV values in tumors.

SUMMARY/CONCLUSION
This educational exhibit will describe and characterize artifact and technical errors. It will illustrate how this can be avoided to obtain optimal perfusion images with accurate CBV, CBF and MTT values. The educational poster will also describe step-by-step how perfusion images can be optimized from the time of scanning to postprocessing.

KEY WORDS: Advanced imaging, imaging marker, radiation necrosis

Electronic Scientific Exhibit 18

Imaging of Peritumoral Region

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Rochester, NY

PURPOSE
The peritumoral region has unique importance in the imaging of brain tumors. There are few signs which have been described on T2 and FLAIR images which can help differentiation of few lesions. However, to a large extent, the conventional MR imaging sequences are not very contributory in visualizing the internal architecture and physiology of the peritumoral region. With the advancement of new imaging technique, better understanding of the peritumoral region is now possible and has a lot of significance in diagnosis and management of brain tumors. Spectroscopy, perfusion and diffusion tensor imaging have been proved to better understand the peritumoral region.

APPROACH/METHODS
We have reviewed our brain tumor cases regarding imaging findings in peritumoral region. The findings on multivoxel MR spectroscopy, MR perfusion and diffusion tensor imaging have been emphasized.

FINDINGS/DISCUSSION
a) Conventional imaging of peritumoral region has certain "signs" although "few" which can be helpful in differentiation of brain tumors. b) The advanced imaging of peritumoral has been an exciting research subject and has helped in understanding of various pathophysiology of brain tumors and many of these findings have great clinical significance. c) MR spectroscopy, diffusion and diffusion tensor imaging appear to be very useful in understanding of peritumoral region and looks to be very promising in differentiating between primary brain tumors and metastases, grading of gliomas, describing the true extent of brain tumors, predicting the spread of tumor and radiation treatment planning.

SUMMARY/CONCLUSION
Findings on various imaging sequences and newer imaging techniques seen in the peritumoral region have been reviewed and will be described in the pictorial essay. The importance of clinically useful findings and signs has been emphasized. We will compare the utility of cerebral blood volume (rCBV), metabolic maps, permeability, fractional anisotropy (FA), apparent diffusion coefficient (ADC), and fiber density index (FDI) values.

KEY WORDS: Peritumoral region, brain tumors, diffusion tensor imaging
Purpose
Diffusion, spectroscopy, perfusion are all valuable tools in the initial diagnosis of mass lesions of the brain. However, these tools can also be used in treatment planning, predicting prognosis and follow up of brain tumors. Spectroscopy and perfusion are markers for the degree of malignancy in brain tumors. Furthermore, the use of these advanced MR imaging techniques is valuable for assessment of therapy, residual tumor after therapy and possible treatment failure and treatment-related complications.

Approach/Methods
We have reviewed our cases at our institution regarding the performance of each modality in follow up of brain tumors. This exhibit will describe the role of diffusion, spectroscopy and MR perfusion in follow up of brain tumors in describing the treatment effect, tumor recurrence, radiation necrosis and therapy-related complications.

Findings/Discussion
a) Advanced MRI techniques like diffusion, MR spectroscopy and MR perfusion have much evolved over the time and now these are very important imaging tools which have been explored as imaging biomarkers to evaluate the disease response. These techniques are helpful in differentiating recurrence from radiation necrosis. These also can predict the response in early stages of the treatment. b) They also can be used in treatment planning and predicting the survival. Each modality has different utility and it is important to a radiologist to use them appropriately in the concerned clinical scenario. c) Various limitations are associated with individual techniques. A combination approach could sometimes be beneficial and more useful.

Summary/Conclusion
This exhibit will be a pictorial essay with review of literature regarding various MR imaging techniques for follow up of patients treated for brain tumors.

Key Words: Perfusion, imaging biomarkers, radiation necrosis

Purpose
To review the pathophysiology of Lyme disease, discuss the current controversy regarding the diagnosis, explore the role of MRI within the diagnostic algorithm, and contribute to the ongoing debate our experience with a series of patients referred for MRI evaluation of neurologic symptoms presumptively related to Lyme encephalopathy.

Approach/Methods
Primary and follow-up MRI studies from a series of patients referred for imaging evaluation of Lyme encephalopathy were read by the neuroradiologist, and the cases were comprehensively reviewed with a neurologist and infectious disease specialist. The imaging findings were correlated with the patient’s clinical course, cerebrospinal fluid (CSF) markers for the disease, and response to specific treatment.

Findings/Discussion
Lyme encephalopathy is a difficult diagnosis for the clinician to make. Sensitivity and specificity of CSF markers for the disease are notoriously low and vary widely according to the processing facility. MR imaging findings attributed to Lyme disease are similar to those defined for multiple sclerosis (MS) and other demyelinating disorders. Despite a putatively definitive article recently published in one of the major medical journals, the topic of Lyme disease remains nebulous and controversial. Our experience (spanning many years within an endemic area) with MRI findings of chronic Lyme encephalopathy is instructive and challenges the radiology community to take an active role in the ongoing discussion.

Summary/Conclusion
Controversy regarding diagnosis and treatment of chronic Lyme encephalopathy rages in the scientific literature and lay press. We present 10 cases referred for MRI evaluation of Lyme encephalopathy. The viewer will consider if MRI helped with the diagnosis and how seriously it should be considered in the differential diagnosis of nonspecific white matter T2 hyperintensities. Imprecision of the final diagnosis in each case challenges the sensitivity and specificity of MRI for Lyme encephalopathy.

Key Words: Lyme, MRI, shimkin
Electronic Scientific Exhibit 21

**Lens Dose in Head CT Scans: Comparison of Standard Thermoluminescent Dosimetry and Realtime Metal Oxide Semiconductor Field Effect Transistor Measurements**

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1Ottawa Hospital, Ottawa, ON, CANADA, 2Health Canada, Ottawa, ON, CANADA

**Purpose**
The population radiation exposure from CT has dramatically increased, leading to increased concern by clinicians, manufacturers, and regulatory bodies (1). Commercial systems are available for real time radiation dose monitoring, based on metal oxide semiconductor field effect transistor (MOSFET) technology. Measurements have been validated in CT phantom studies against thermoluminescent dosimetry (TLD) in the neck, chest and abdomen (2). The goal of the current study was to correlate the eye (lens) radiation measurements made on a MOSFET system with standard TLD measurements, in patients undergoing routine noncontrast head CT.

**Approach/Methods**
The study was performed on patients scheduled to undergo routine noncontrast head CT scans performed on 16 slice (GE Lightspeed Ultra) or 64 slice (GE Lightspeed VCT) scanners. The patients either have helical CT acquisition or standard sequential acquisition. Helical scans were performed at 120 kVp and 300 mA, 0.5s tube rotation, slice thickness 0.625 and pitch ~ 0.5 (0.531 for the 64 slice and 0.562 for the 16 slice). Sequential scans performed with the 16 slice scanner used 140 kVp, 190 mA, 5 mm slice thickness (posterior fossa) and 120 kVp, 190 mA, 7.5 mm slice thickness (remainder of brain). The corresponding parameters for the 64 slice scanner were 140kVp, 170 mA, 5 mm slice thickness (posterior fossa) and 120 kVp, 150 mAs, 5 mm slice thickness (remainder of brain). For the TLD measurement TLD-100H “copper dopes” chips sized 1/8 X1/8 X 0.035 packaged in groups of two were used. The chips were read out with a Harshaw 5500 reader using manufacturer recommended time temperature profile (TTP). All chips were read out twice to zero the chips prior to packaging. Chips after exposure were read and corrected for sensitivity (batch sensitivity) and energy response (calibrated for 120kVp). The mobile MOSFET wireless dose verification system (Best Medical, Ottawa, Ontario) was used. Thirteen patients (7 helical and 6 sequential) were scanned in the 16 slice scanner while 39 patients (21 helical and 18 sequential) were scanned in the 64 slice scanner. The dose to the right lens was measured by a MOSFET taped to the eyelid and similarly left lens dose was measured by a TLD taped to the eyelid. The correlation of these measurements was performed using Pearson’s rank coefficient.

**Findings/Discussion**
There was good correlation between the MOSFET and TLD measurements, with Pearson’s rank coefficient (r) value of 0.89 p = < 0.001 (sig. 2-tailed). This was true for both groups and image quality of both acquisition techniques were comparable.

**Summary/Conclusion**
MOSFET measurement of lens dose in noncontrast head CT is easy to perform and correlates well with standard TLD measurements, and may provide a useful real time quality assurance tool.

**References**

**Key Words:** CT dose, MOSFET, TLD

Electronic Scientific Exhibit 22

**Gadolinium Use in the Nephrogenic Systemic Fibrosis Era: Strategies for Enhancing Patient Safety**

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Durham, NC

**Purpose**
To develop rational institutional strategies for the use of gadolinium chelates in patients who are at risk for nephrogenic systemic fibrosis (NSF).

**Approach/Methods**
Current recommendations for gadolinium use were reviewed and evaluated; these included guidelines and mandates by the FDA, European Medicines Agency (EMEA), United Kingdom Medicines and Healthcare products Regulatory Agency (MHRA), and American College of Radiology (ACR) panel, among others. Relevant literature and cases of NSF were reviewed. These items were evaluated to formulate an institutional policy for the administration of gadolinium. Considerations and analysis are applicable to other hospitals and practices struggling with formulation of this type policy.

**Findings/Discussion**
Patient screening recommendations were formulated to evaluate risk factors for renal function. Step-by-step instructions for patient evaluation based on chronic renal failure stage and screening for other factors including acute renal failure and liver failure were optimized.

**Summary/Conclusion**
Evaluating MRI patients for gadolinium contrast requires a dedicated policy for improving patient safety. Considerations of regulations and guidelines, patient medical conditions, and optimizing clinical practice and institutional policy are needed to provide the best strategy.

**Key Words:** Contrast, MRI, NSF
Electronic Scientific Exhibit 23

3.0 T MR Imaging of Pituitary Adenomas: The Differential Diagnosis Revisited

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PURPOSE
To propose a method for optimizing the differential diagnosis of pituitary adenomas.

APPROACH/METHODS
We illustrate a systematic analysis of MR images through a checklist of 15 semioologic items that can help in differential diagnosis of pituitary adenomas.

FINDINGS/DISCUSSION
1) Sella/bone changes: in pituitary macroadenomas, the sella usually is enlarged whereas it is not enlarged and frequently hyperintense on T1-W in meningiomas. Hyperintensity of the planum sphenoidale can be seen after surgery or radiotherapy, in meningioma and in elderly. 2) Location/sella: a tumor located above the pituitary is not a pituitary adenoma. 3) Signal T1/T2: signal is usually more homogeneous in tumor located above the pituitary is not a pituitary adenoma.

Summary/Conclusion
A systematic checking of 15 semioologic items can be helpful in the differential diagnosis of pituitary adenomas.

Key Words: Pituitary adenoma, pituitary gland, MR studies

Electronic Scientific Exhibit 24

Imaging of Cryptic and Noncryptic Cerebrovascular Malformation

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PURPOSE
1) To review the etiopathogenesis and radiologic appearances of different types of cerebrovascular malformation and 2) To illustrate with various types of cerebrovascular malformations with special attention to cryptic form.

APPROACH/METHODS
The diagnostic images (CT, 3DCT, MRI, MRA, CTA and DSA) of 241 patients with cerebrovascular malformation serve the basis of this exhibit. Various cases and selective images were selected which demonstrates the cryptic and noncryptic malformations involving the central nervous system.

FINDINGS/DISCUSSION
Intracranial vascular malformations are classified into four subtypes namely arteriovenous malformation/AVM (intraparenchymal, dural), venous angioma, cavernous malformation and capillary telangiectasia. In this exhibit we discuss the embryology, etiopathogenesis of cryptic malformation (namely cavernous angioma, capillary telangiectasia, and thrombosed AVMs) and noncryptic type (AVM and venous angioma). Various radiologic appearances and at different anatomical locations are illustrated along with its differential diagnosis. Developmental venous anomalies were the most common of all cerebral vascular malformations, which were almost four times more common than AVMs. In addition we discuss the complications and mimics of these four lesions.

Summary/Conclusion
This exhibit will be a core learning tool for the cryptic and noncryptic vascular malformations of central nervous system. With the advent of MRI, especially GRE (gradient echo) sequence cryptic group and venous angioma are diagnosed quite frequently.

Key Words: Cerebrovascular malformation, cryptic...
Electronic Scientific Exhibit 25

Comprehensive Review of Imaging of Epilepsy

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PURPOSE
To understand the etiology, pathogenesis and various radiologic appearances in hippocampus sclerosis. To illustrate the usefulness of high-resolution MRI scanning in identifying the nonhippocampal substrate.

APPROACH/METHODS
Over the past 3 years, we retrospectively reviewed the imaging studies (CT, MRI) of 240 patients with clinical diagnosis of epilepsy confirmed either clinically, 24-hour video monitoring and EEG or combination of three. The diagnostic images (CT, MRI, MRA, PET and SPECT) of these patients served as the basis of this exhibit.

FINDINGS/DISCUSSION
Radiologic findings were classified broadly into hippocampal and nonhippocampal pathologies. Hippocampal abnormalities were classified further into mesiotemporal sclerosis and nonsclerotic abnormalities like heterotopias, tumor, encephalitis. Nonhippocampal abnormalities were classified further into 1) malformation of cortical development (a) due to abnormal neuronal and glial proliferation, (b) due to abnormal neuronal migration and (c) due to late migration and organization; 2) neoplasm; 3) vascular abnormalities; and 4) miscellaneous.

SUMMARY/CONCLUSION
High-resolution dedicated epilepsy protocol imaging has revolutionized the evolution, classification and management of epilepsy. It has allowed the determination of the structural substrate for epilepsy in many cases and helps to determine prognosis for remission or intractability. High-resolution imaging in different planes plays a vital role in identifying the substrate and management.

KEY WORDS: Epilepsy, hippocampus, nonhippocampus

Electronic Scientific Exhibit 26

Dissecting the White Matter Tracts: Interactive Diffusion Tensor Imaging Teaching Atlas

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PURPOSE
To provide an interactive tutorial for exploring the white matter geography of the brain as visualized on diffusion tensor imaging (DTI) tractography.

APPROACH/METHODS
Original diffusion tensor images of a normal brain are used to detail the different white matter tracts and their major functions. As the user navigates the program, hyperlinks provide opportunity to explore or revisit details related to each pathway. Included is a digital atlas for reference and review. The atlas includes a feature whereby users can select locations in the brain for hypothetical lesions and see which white matter tracts would potentially be affected. Pre and posttests are included for self-evaluation.

FINDINGS/DISCUSSION
A teaching module and interactive digital atlas are created for self-exploration of the white matter tracts as visualized on diffusion tensor imaging.

SUMMARY/CONCLUSION
Diffusion tensor imaging tractography is becoming increasingly helpful in clinical practice, especially in the setting of presurgical tumor evaluation. A working knowledge of the major white matter tracts and their functions is essential to provide information useful in guiding clinical decisions. This module serves as a primer or refresher of white matter tract anatomy, as well as a reference atlas to assist with image interpretation and therapeutic planning.

KEY WORDS: Tractography, DTI, anatomy

Electronic Scientific Exhibit 27

Multiple Sclerosis: Update on MR Imaging Diagnostic Criteria

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PURPOSE
Although the diagnosis of multiple sclerosis (MS) continues to be based on clinical findings, MRI is now integrated in the overall diagnostic scheme of the disease because of its unique sensitivity to demonstrate the spatial and temporal dissemination of the demyelinating plaques in the central nervous system (CNS). The purpose of this exhibit is to critically review the different diagnostic MRI-based criteria proposed in the last years.

APPROACH/METHODS
Review of the existent data related to different MRI-based criteria used in the diagnostic scheme for MS.

FINDINGS/DISCUSSION
Various criteria have been developed to classify MRI findings as suggestive of MS or not. Probably the most relevant are those of Barkhof-Tintoré (1, 2), which showed higher accuracy and specificity than the previous MRI criteria for predicting conversion to clinically definite MS. Because of their specificity for MS, in 2001 an international panel on the diagnosis of MS incorporated the Barkhof-Tintoré criteria into their scheme for demonstrating DIS, while demonstration of new lesions at least 3 months after the clinical onset was proposed as the criterion for DIT (3). Various authors have argued that these criteria are too restrictive for MR demonstration of DIT, and are partially vague and confusing, particularly regarding the role of spinal cord MR imaging. Some studies have explored potential modifications of the original McDonald criteria. To this purpose, in 2005 an inter-
national panel reviewed the progress attained since the original McDonald criteria were developed, and recommended appropriate changes, such as simplification of the criteria for DIT, better definition of the role of spinal cord MR imaging in the diagnostic scheme, and simplification of the original criteria for the diagnosis of primary progressive MS (4). More recently new criteria have been proposed for both DIS and DIT, which were based mainly on the topographical characteristics of the lesions (5). When applied to a large cohort of CIS patients, these new criteria have demonstrated similar (high) specificity for clinically definite MS and higher sensitivity as compared with the 2001 McDonald criteria (6).

**SUMMARY/CONCLUSION**

New evidence-based data support the need of revision of the MRI diagnostic criteria for MS aimed toward optimizing the examination in terms of ease, simplicity, and cost. Nevertheless, we should keep in mind that for optimal application of the various MRI criteria, scans must be technically adequate, and physicians involved in the diagnostic work up must be provided with sufficient clinical information to properly interpret the imaging findings and be expert enough to recognize the full range of brain and spinal cord abnormalities that suggest the diagnosis of MS.

**REFERENCES**


**KEY WORDS:** Multiple sclerosis, diagnosis, MRI

**Electronic Scientific Exhibit 29**

**Review of Anatomy and Pathology of the Choroidal Vasculature**

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**PURPOSE**

A pictorial review of the anatomy and potential neurovascular pathologies of the anterior and posterior choroidal circulation is presented. Angiographic anatomy is presented including anatomical variants. The vascular territories supplied by these vessels are discussed along with the clinical consequences of occlusion in relation to the portion of vessel affected, taking into account the effects of collateralization. A broad spectrum of neurovascular pathology is presented including aneurysms, arteriovenous malformations (AVMs), thrombo-embolic disease and tumors involving this interesting anatomical region.

**APPROACH/METHODS**

Carotid and vertebral angiograms (with complementary CTA and MRA studies) from our patient data base were reviewed to analyze variations of the anterior choroidal artery (AChA) and posterior choroidal arteries (medial and lateral PChA) respectively. The arteries were assessed for their origin, size, course of the stem, identification of the perforating branches
and the cisternal and plexal segments. We analyzed anatomical anomalies and highlighted pathologic cases and correlated them with clinical findings.

**FINDINGS/DISCUSSION**

With modern digital subtraction angiography visualization of the AChA is possible in the great majority of cases despite its small caliber. We describe a multitude of AChA and PChA variations including aberrations in origin, course and number. Hypoplastic and hyperplastic anatomical anomalies are described and classified into subtypes according to the distribution, area, and course of the vessel. Interchangeability of the brain regions supplied also is discussed with particular emphasis on vessels with significant risk of surgical or endovascular occlusion. Characteristic angiographic changes in the course and configuration of choroidal arteries are seen with respect to tumors and we describe relevant anatomical landmarks. We look at the clinical spectrum, the course, and the mechanism of infarcts involving the choroidal artery territories. AChA and PChA aneurysms and AVMs, although rare, present a significant clinical dilemma. The treatment of such aneurysms is surgically and endovascularly challenging. We present a number of cases with discussion of treatment and patient management.

**SUMMARY/CONCLUSION**

The anterior choroidal artery (AChA) is a major branch of the supraclinoid internal carotid artery and the lateral and medial posterior choroidal arteries are small but critical branches of the posterior cerebral artery. Thorough knowledge of the anatomy of the intracranial vessels is important for diagnostic assessment as well as for interventional therapy and presurgical planning. We review the angiographic anatomy and pathology of these complex vascular territories.

**KEY WORDS:** Anterior choroidal, posterior choroidal, aneurysm
Electronic Scientific Exhibit 31

Dangerous Areas in Head CT Interpretation: Lessons Learned from a Long-Term Resident Quality Assurance Process

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PURPOSE
Computed tomography (CT) of the head is one of the most common imaging studies performed in radiology. It is typically the first line imaging test in patients with acute neurologic symptoms. Interpretation may be challenging, especially in the acute setting when abnormal findings may be subtle. A robust quality assurance process can assist in documenting misinterpretations and form the basis of resident education efforts with the goal of improving patient care.

APPROACH/METHODS
At our institution, a robust quality assurance system for resident preliminary interpretations has been in place for almost 4 years, from January 2004 to date 2007. This serves as the data base from which common regions and scenarios of misinterpretation are illustrated. The exhibit will highlight the areas on head CT where subtle pathology can be difficult to detect along with multiple examples and illustrations.

FINDINGS/DISCUSSION
During the time period of QA data collection, 20234 CT scans of the head were interpreted by radiology residents on overnight call. Clinically significant discrepancies occurred in 3.90% (major 0.14%, minor 3.76%). Of these discrepancies, 11.79% were related to misinterpreted intracranial hemorrhage, 9.5% were related to a combination of acute and nonacute infarcts/ischemia. Of these discrepancies, 2.6% were due to misinterpreted intracranial edema and 4% were related to intracranial masses. Other discrepancies included misinterpretation in identifying intracranial mass effect, fractures, and extracranial pathology. Based upon the data from our QA system, a rational approach to these “danger areas” is presented with recommendations for identification, using multiple case examples. A structured “checklist” for interpretation is presented that may aid in identifying commonly missed intracranial abnormalities.

SUMMARY/CONCLUSION
Head CT is the most commonly performed examination in neuroradiology. Interpretation can be difficult and misinterpretations are not uncommon. Application of knowledge gained from a long-term robust QA process can elucidate these “danger areas”, improve interpretation accuracy, and ultimately improve patient care.

KEY WORDS: CT head misinterpretations, quality assurance

Electronic Scientific Exhibit 32

Role of Diffusion Tensor MR Imaging in Defining the Differential Diagnosis between Mild Cognitive Impairment and Alzheimer Disease

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PURPOSE
To evaluate the fractional anisotropy (FA) values of several white matter tracts, aiming to differentiate the normal population from mild cognitive impairment (MCI) and Alzheimer disease (AD) patients.

APPROACH/METHODS
Seventy-nine patients with memory impairment (MCI, possible AD, and probable AD) and 16 age- and gender-matched controls were studied. MRI studies were performed on a 1.5T scanner. Conventional images and diffusion tensor imaging (DTI) were obtained in all participants. The DTI data were postprocessed and based on FA maps, FA values were measured in regions of interest (ROIs) positioned in the hippocampal formations, superior longitudinal fascicles, posterior cingulate gyrus, and the splenium of the corpus callosum. Kruskal-Wallis and Steel-type multiple comparisons nonparametric tests were applied for the statistical analysis. Relations between variables were assessed with nonparametric Spearman and Pearson correlations.

FINDINGS/DISCUSSION
The FA values for the splenium of the corpus callosum, bilateral posterior cingulate gyri, and bilateral superior longitudinal fasciculi of MCI and probable AD patients were significantly lower than controls (p = 0.01 and p = 0.03). No significant difference was noted in FA values when comparing MCI versus possible AD and probable AD, and probable AD versus possible AD. No differences in FA values were seen in hippocampal formations among patients from all groups.

SUMMARY/CONCLUSION
In conclusion, the anatomical regions first involved in patients with cognitive impairment demonstrated reduced FA values compared with controls. However, the FA values did not allow the differentiation between MCI, possible and probable AD.

KEY WORDS: Dementia, diffusion tensor imaging, MRI
To evaluate the diffusion tensor imaging (DTI) abnormalities in the brain lesions of patients with human lymphotropic virus type I (HTLV I) associated myelopathy/tropical spastic paraparesis (HAM/TSP).

**METHODS**

We studied 11 cases of HAM/TSP, and an age- and gender-matched control group. All patients underwent brain MRI at 1.5T scanner, with conventional protocol and DTI (64 directions). The DTI data were postprocessed and fractional anisotropy (FA) maps calculated. The FA values were measured in regions of interest (ROIs) positioned in the white matter lesions, normal-appearing white matter (NA WM) around the lesions, as well as NA WM more than 1 cm distant from the lesions and contralateral. In the control group, the ROIs were placed in regions similar to the lesions of the study group. The FA values were compared between the groups, and the statistical treatment was performed with the Mann-Whitney U test.

**RESULTS**

The FA values were significantly reduced in the white matter lesions (mean FA = 0.285) and in the NA WM around the lesions (mean FA = 0.386) compared with controls (mean FA = 0.662) (p < 0.001). However, there was no significant difference between the FA values of the NA WM more than 1 cm distant from the lesions (mean FA = 0.602) and contralateral to the lesions (mean FA = 0.587), compared with the controls (mean FA = 0.662) (p > 0.05).

**SUMMARY/CONCLUSION**

The DTI allows accurate evaluation of the white matter lesions in patients with HAM/TSP. Our results demonstrated reduced FA values in the lesions and NA WM around them, but no significant abnormalities in the NA WM distant from the lesions or contralateral.

**KEY WORDS:** Infectious diseases, MRI, brain
Essentials of Arterial Spin Labeling Imaging in Assessment of Alzheimer Disease

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PURPOSE
To develop criteria for visual diagnosis of Alzheimer disease (AD) utilizing magnetic resonance arterial spin labeling (ASL).

APPROACH/METHODS
Sixteen cognitively normal (CN) age-matched elder, and 14 AD patients underwent modified arterial spin labeling (ASL) imaging using alternating single and double adiabatic inverions (ASD) (3.7 s pulse train at 92% duty cycle) and ramp-sampled echo-plane imaging (EPI) to acquire 19 contiguous axial slices (64 x 64 matrix, 20 cm field-of-view, 5 mm slice thickness, 0 spacing, 21 ms echo time (i.e., minimum full), 76 kHz effective receiver bandwidth, 1 s acquisition time, 700 ms transit delay, 900 flip angle). rCBF was calculated via modified Buxton equation and averaged for 12 regions identified by Talairach atlas as controls: hippocampus, superior temporal, globus pallidus, amygdyla, orbitofrontal, anterior and posterior cingulate, lateral prefrontal, superior parietal, precuneus, thalamus, and lentiform. Imaging findings of CN and AD are presented in Powerpoint format. Calculated rCBF are also presented. Eighteen unknown ASL images are presented asking for their diagnosis. Then their rCBF values are presented, and the unknowns reviewed again. Final results were tabulated from three blinded neuroradiologists with MR experience ranging from a fellow trainee, to junior and senior faculty and interobserver ratings tabulated. Each unknown was scored for thickness of the cortex, uniformity of the cortex signal, presence of gaps, and overall intensity based on color mode display. Presence of bright spots (marked increased signal intensity) were recorded, and finally a diagnosis of the unknown was made.

FINDINGS/DISCUSSION
Cognitively normal showed thick, uniform cortex with no focal gaps and a robust thalamus, caudate, and lentiform with strong cortex signal intensity ranging from warm to bright red with yellow and white signal. Cognitively normal also showed characteristic bright spots on ASL corresponding to regions of increased perfusion. Alzheimer disease showed thinned at times absent cortex with small and large focal gaps and signal intensity of dark to warm red. Bright spots were absent most notably the anterior and posterior cingulate, and the orbitofrontal. Visual inspection alone resulted in a 60% accuracy which was improved to 73% utilizing the calculated rCBF. In general hypoperfused regions showed lower signal intensity, and hyperperfused showed higher signal intensity.

SUMMARY/CONCLUSION
In general visual differentiation of CN from AD could be made. Those in which the diagnosis was not correct were in the CN group whose images resembled that of AD, and also AD who appeared to be normal. Thus the criteria are not reli-

able for individual cases, but were useful when the entire CN or entire AD findings were summated. Those that resembled AD may in fact be early AD patients who have somehow compensated and did not manifest clinical symptoms. Long-term follow-up exams in these are still pending. Thus the ASL findings may suggest early on the predilection for development of AD in these CN. Further refinement of these criteria are necessary as more ASL studies are being performed. Arterial spin labeling may prove to be a useful clinical as well as research tool.

KEY WORDS: Arterial spin labeling, functional circuitry, Alzheimer disease

Electronic Scientific Exhibit 36
Perfusion CT Imaging of Brain Tumors: An Overview
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PURPOSE
Evaluation of tumor angiogenesis using in vivo perfusion imaging techniques can help in predicting tumor grade, prognosis, treatment response and patient survival. Perfusion imaging of brain tumors has been done traditionally using various MR perfusion techniques. The purpose of this electronic scientific exhibit is to review the role of perfusion CT imaging in brain tumors.

APPROACH/METHODS
A brief review of CT perfusion technique and postprocessing will be done. Role of perfusion CT imaging in brain tumors will be discussed including its use in preoperative glioma grading, assessment of glioma angiogenesis and differentiating recurrent tumor versus radiation necrosis. We will include examples of perfusion CT maps from our teaching cases. Use of perfusion CT to differentiate tumors from non-neoplastic lesions as well as differentiating between lymphoma and gliomas also will be discussed. Finally, advantages and limitations of perfusion CT will be discussed.

FINDINGS/DISCUSSION
Tumor neoangiogenesis is often a significant independent prognostic factor in overall and disease-free survival and in vivo measurement of tumor angiogenesis can help grade tumors. Low grade gliomas demonstrate lower blood volume and permeability as compared to high grade gliomas, as a consequence of their lower microvascular density. Conversely, tumors with more immature vasculature (increased neoangiogenesis, microvascular density and microvascular cellular proliferation) demonstrate higher tumor vascular permeability and blood volume. Hence, it is possible to grade brain tumors based on various perfusion parameters, especially tumor blood volume and permeability surface-area product measured using perfusion CT have shown a good correlation with glioma grading. Perfusion CT can be an important tool for in vivo tumor angiogenesis analysis, helping modify treatment based on the differences and heterogeneity within a tumor. Posttreatment use of perfusion CT includes differentiation of radiation necrosis and recurrent tumor, since radiation necrosis demonstrates lower blood volume versus recurrent tumor. Another utility of per-

Electronic Scientific Exhibits
fusion CT is that gliomas demonstrate increased blood volume compared to lymphoma, allowing differentiation of the two disease processes in certain difficult clinical scenarios. Similar principle also can be used to differentiate neoplasms from nonneoplastic disease processes such as tumefactive multiple sclerosis.

SUMMARY/CONCLUSION
Perfusion CT can be used easily and quickly for brain tumor assessment preoperatively as well as a follow-up imaging tool helping make management decisions. In vivo tumor angiogenesis imaging also can be useful for evaluation of the whole tumor which may not be possible with histopathology, which can help modify brain tumor treatment options in future.

REFERENCES

KEY WORDS: Perfusion, tumor, CT

Electronic Scientific Exhibit 38
Nontraumatic Neurologic Emergencies of the Brain
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PURPOSE
To provide an educational exhibit illustrating wide spectrum of nontraumatic neurologic lesions of the brain that can present in the emergency settings. Approach is based on categorizing these lesions into vascular, infectious, inflammatory, metabolic and neoplastic categories with an emphasis on characteristic imaging features, differential diagnosis and clinical context.

APPROACH/METHODS
We retrospectively reviewed a broad range of pathologically and/or clinically proved cases of nontraumatic lesions of the brain which presented acutely in the emergency settings at a busy level I trauma center. These cased were divided into vascular, infectious, inflammatory, metabolic and neoplastic. We will present representative cases from each category.

FINDINGS/DISCUSSION
Craniospinal injuries account for the majority of requested neuroradiologic studies in a trauma center and both residents and faculty are attuned to the findings on CT and MRI. However, there are many other pathologic processes that can present in the emergency setting. Stroke is the most common such condition and can present as arterial infarction, venous infarction, intraparenchymal hemorrhage or subarachnoid hemorrhage. Intraparenchymal hemorrhage can be due to hypertension, amyloid angiopathy, anticoagulation, tumors and vascular malformation. Ruptured aneurysm is the most common cause of nontraumatic subarachnoid hemorrhage. The other causes that are not uncommon can be categorized as infectious such as meningitis, abscess, subdural empyema and encephalitis; metabolic such as Wernicke’s encephalopa-
thy, osmotic demyelination: vascular such as posterior reversible encephalopathy syndrome, global hypoxia; inflammatory such as acute disseminated encephalomyelitis and multiple sclerosis; and neoplastic causes, especially in the posterior fossa, presenting acutely with brain herniation and obstructive hydrocephalus. Awareness and familiarity with these conditions is important to avoid any pitfalls and misdiagnosis.

**SUMMARY/CONCLUSION**
The viewer of this exhibit will benefit from the knowledge of the characteristic imaging features, differential diagnosis and clinical presentation of wide variety of nontraumatic neurologic emergencies of the brain for clinical practice and for preparation for certifying examinations.

**KEY WORDS:** Neurologic emergencies, stroke, infectious

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**Electronic Scientific Exhibit 39**

**Location of Focal Ischemic Changes, Perfusion Abnormalities and Angiographic Findings as Predictors of the Etiology of Acute Ischemic Stroke: A Pictorial Display**

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**PURPOSE**
In the clinical practice and in the setting of research, the assessment of the ischemic stroke subtype is important, to define prognosis, risk of recurrence and choices for management. Extensive workup is often necessary to classify an acute infarct within one of the five categories established by the TOAST investigators in 1993. However, in the acute setting, the distribution of the infarcted territory, its penumbra and the status of the vascular system are used to attempt to predict the etiology and guide the early intervention. The objective of this presentation is to provide a pictorial description of the imaging findings of patients with acute stroke in specific vascular territories and atypical distributions, correlating with the angiographic appearance to determine the etiology.

**APPROACH/METHODS**
We present series of nonenhanced CT and MRI, perfusion studies and different modalities of angiography to illustrate the typical territorial distributions of ischemic changes and perfusion abnormalities, and discuss the role of the imaging studies to achieve the etiologic diagnosis. We also show examples of infarcts in which anatomical variants, such as azygous anterior cerebral artery or incomplete circle of Willis, or preexisting vascular conditions result in a rather atypical appearance.

**FINDINGS/DISCUSSION**
Large artery atherosclerosis and cardioembolism usually present as cortical or cerebellar lesions, or brainstem or subcortical infarcts greater than 1.5 cm in diameter. Stenosis greater than 50%, or occlusion of a major brain artery or branch cortical artery are frequently found in the angiographic studies. The location and morphology of the occlusive vascular changes are useful to determine the probable etiology. Small artery occlusion (lacune), which occurs more frequently in patients with diabetes mellitus and hypertension, usually presents without CT/MRI abnormality, or with brain stem or subcortical hemispheric lesion with a diameter of less than 1.5 cm. Acute stroke of other determined etiology comprises rare causes of stroke, such as nonatherosclerotic vasculopathies, hypercoagulable states, or hematologic disorders. The location of the lesions is nonspecific; however, the arteriogram or venogram can show abnormalities that may narrow down the differential diagnosis. The last category, stroke of undetermined etiology, clusters the patients with incomplete evaluation, undetermined etiology in spite of a complete evaluation and multiple possible etiologies.

**SUMMARY/CONCLUSION**
In the setting of acute ischemic infarct, the distribution of the focal abnormalities and the status of the vascular structures help to predict the etiology of the ischemic infarct and guide the early interventions. Familiarity with the typical and atypical appearances of ischemic lesions, perfusion abnormalities and angiographic findings in CT, MRI and conventional angiography are of paramount importance to determine the management.

**KEY WORDS:** Stroke, territory, etiology

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**Electronic Scientific Exhibit 40**

**Understanding Cerebral Perfusion MR Imaging**

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**PURPOSE**
Brain MR perfusion is an imaging technique used to study the microvasculature in conditions such as stroke, the investigation of vasospasm in SAH and head injury. In addition, MR perfusion imaging is used increasingly in the investigation of brain tumor angiogenesis to grade the tumor, distinguish radiation necrosis from tumor recurrence and also to assess the response of novel antiangiogenic agents. Typically, commercially available software packages calculate CBV, CBF and MTT, however, some studies have shown that other parameters are also important such as permeability surface area product (Ktrans). These newer parameters are calculated with homemade software packages and the calculations and interpretation require more detailed understanding. We intend to review the technique, nomenclature and major clinical applications of MR perfusion.

**APPROACH/METHODS**
We will describe the different techniques for determining perfusion parameters. A detailed description of the physiologic basis of perfusion parameters including the definition of the parameters CBV, CBF, MTT, Ktrans, V_e and V_p. We will illustrate the potential clinical applications of MR perfusion in tumor imaging.

**FINDINGS/DISCUSSION**
A detailed description of the different PWI methodologies using endogenous and exogeneous contrast agents is provided. This includes dynamic contrast-enhanced, dynamic sus-
ceptibility contrast and arterial spin labeling techniques. A discussion of the different parameters that may be calculated from the MR perfusion data. These parameters include, $K_{\text{trans}}$, rCBV, rCBF, MTT, $V_e$ and $V_p$. The pathophysiologic basis of these perfusion parameters is illustrated using high-grade brain tumors where the angiogenesis is one of the pathologic hallmarks. Tumor-related angiogenesis has two important components, increased numbers of capillaries and increased leakiness of the microvessels. Both of these can be estimated by MR perfusion imaging using rCBV, which represents the capillary density and $K_{\text{trans}}$ which measures the passage of contrast media from the intravascular to the extravascular-extracellular space. High-grade tumors are characterized by increased numbers of abnormal blood vessel and abnormally leaky blood vessels which can be detected as an increased rCBV and $K_{\text{trans}}$.

**SUMMARY/CONCLUSION**
The reader will gain an understanding of the MR perfusion techniques, definitions of the main parameters and application in brain tumor imaging.

**KEY WORDS:** MR perfusion, brain neoplasms

**Electronic Scientific Exhibit 41**

**Understanding Diffusion Tensor Imaging**

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**PURPOSE**
In the brain, the movement of water can occur in any direction. When free water molecules diffuse in unequal directions, as in the white matter (WM) tracts, it is called anisotropic diffusion. The displacement of water molecules is greater parallel to the long axis of a fiber bundle than perpendicular to it. Diffusion tensor imaging (DTI) is a relatively recent technique that describes the degree of diffusion anisotropy using fractional anisotropy (FA) and the local fiber direction. Diffusion tensor imaging is capable of showing the microstructural development of white matter and abnormalities in several diseases, including dysmyelination and demyelination states, neurodegenerative disease and brain tumor. We intend to review the DTI technique, its nomenclature and its application in WM analysis.

**APPROACH/METHODS**
We will describe the physics of DTI, the usual DTI nomenclature including, relative anisotropy, FA and volume ratio. The DTI acquisition protocol and the data manipulations required to generate FA values will be illustrated. The physiologic and pathophysiologic significance of FA will be discussed.

**FINDINGS/DISCUSSION**
In the WM, the direction of maximum diffusivity is parallel to the fiber tract direction. The anisotropy results from the presence of natural barriers, such as axonal membranes and myelin sheaths. The diffusion tensor consists of a 3 x 3 matrix and the diffusivity measurements are made in at least six directions. The tensor matrix may be represented as an ellipsoid, whose diameter in any direction estimates the magnitude of the diffusivity in that direction. The eigenvalues represent the three principal diffusion coefficients in the three orthogonal directions called eigenvectors. The FA is a common anisotropy parameter and represents the standard deviation of the three eigenvalues. In brain maturation, the presence of myelin sheaths, axonal membranes and glial cells growth results in an increase in the FA. The failure of an increase in the FA with age is indicative of the presence of an abnormal condition. Because in these situations there is loss of the normal tissue microstructural organization and water diffusion becomes less anisotropic (more equal in all directions). In our institution the DTI protocol is composed of single-shot spin-echo planar sequence, 12,000/101 (TR/TE). Field-of-view, 20 cm²; matrix size of 128 x 64; 6 mm contiguous slices, number of excitations, 4; b value 1.000 s/mm². The raw diffusion tensor data are transferred to a workstation (Advantage Windows v3.0, GE Healthcare) and processed. The FA map is generated with Functool software (GE Healthcare). On this map, we draw regions of interest (ROIs) that give us the FA measurement of a specific brain structure. A color-coded map of fiber orientation and tractography also can be generated.

**SUMMARY/CONCLUSION**
The audience will gain an understanding of the DTI technique, its usual nomenclature and its clinical applications in normal development and abnormal states of WM.

**KEY WORDS:** Diffusion tensor imaging, MRI, brain maturation

**Electronic Scientific Exhibit 42**

**Active MS Plaques: Efficiency of Magnetization Transfer Subtraction Technique**

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**PURPOSE**
To evaluate the contribution of subtraction magnetization transfer (MT) technique in depiction of multiple sclerosis (MS) patients with acute episodes.

**APPROACH/METHODS**
Sixty-four cases (M/F: 42/22, mean age: 32 years) with acute MS episode were enrolled in this clinical study. MR imaging protocol included T1-weighted SE axial with MT, T2-weighted TSE axial-sagittal and FLAIR axial sequences. Following contrast agent injection T1 SE sequences with MT in three planes were acquired. Subtraction images (postcontrast MT images-precontrast MT images) were obtained on the workstation. FLAIR and T2-weighted images were used as reference for plaque imaging. Contrast-enhanced plaques were considered as acute plaques. Qualitatively, both subtracted images and contrast-enhanced MT images were evaluated visually. Quantitatively, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated. Statistical significance was accepted as $p < 0.05$ (ANOVA).
Findings/Discussion
Four hundred sixty-four plaques were detected on T2-weighted and FLAIR images. Thirty-five acute plaques were depicted on both contrast-enhanced MT and subtracted images. Additionally 66 acute plaques were only detected on subtracted images visually. Contrast-to-noise and SNR values of acute MS plaques were significantly higher on subtracted MT images compared to contrast-enhanced MT images (p < 0.001).

Summary/Conclusion
Subtraction technique seems to amplify the depiction of acute MS plaques by intensifying the visibility of poorly enhanced plaques without use of high-dose contrast medium. We suggest the use of subtraction technique in routine imaging workup of MS patients with acute episodes.

Key Words: Multiple sclerosis, MRI, magnetization contrast

Electronic Scientific Exhibit 43
Solitary Metastases and High-Grade Gliomas: Radiologic Differentiation by Morphometric Analysis and Perfusion-Weighted MR Imaging

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Purpose
To evaluate the efficiency of morphometric analysis and perfusion-weighted MRI in differential diagnosis of hemispheric solitary metastases showing similar radiologic imaging characteristics with high-grade gliomas in a large series.

Approach/Methods
One hundred sixty tumors which have obtained conventional and perfusion-weighted MRI were screened retrospectively. Among those tumors, 22 high-grade gliomas and 26 solitary metastases with similar conventional MRI findings. The relative cerebral blood volumes (rCBV) of lesions were proportioned with normal white matter mean CBV value, and measurements were carried out from intratumoral and peritumoral areas. Morphometric analysis was measured by proportioning area of peritumoral edema with mass area. Mann-Whitney U test and ROC curve analysis were applied for statistical analysis.

Findings/Discussion
While intratumoral mean rCBV value was 5.02 ± 2.47 in high-grade gliomas, it was 4.62 ± 2.46 in metastases. The difference was not statistically significant (p = 0.515). Peritumoral edema rCBV value was 0.89 ± 0.51 in high-grade gliomas and 0.31 ± 0.12 in metastases. The difference was statistically significant (p < 0.001). According to the results of morphometric analysis, a statistically significant difference was present between the two tumor types (p < 0.001). The area under ROC curve was calculated to be 0.939. When cut-off value was determined to be 0.91, sensitivity and specificity were 89% and 93%, respectively.

Summary/Conclusion
Measuring peritumoral edema/tumor area and mean rCBV values of the edema surrounding the tumor, prior to operation in solitary metastases and high-grade gliomas, proves to be useful for distinctive diagnosis. Intratumoral rCBV values do not provide additional information in radiologic differentiation.

Key Words: Gliomas, metastases, perfusion imaging

Electronic Scientific Exhibit 44
Applications of CT Perfusion in Acute Stroke Situations: Technique and Usefulness in a Busy Stroke Center
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Purpose
To familiarize clinicians and radiologists with usefulness of CT perfusion in acute stroke situations.

Approach/Methods
Description of imaging technique, interpretation, and pitfalls followed by a demonstration of the usefulness of CT perfusion through an interactive decision-making exhibit illustrated by selected case models and followed by an interactive question and answer section to reinforce the presented material.

Findings/Discussion
This is an interactive electronic exhibit with which clinicians can appreciate the usefulness of this technology as demonstrated in selected case models in the decision-making process for the acute management of stroke.

Summary/Conclusion
This exhibit illustrates the emerging important role of CT perfusion in the acute stroke setting as it has been shown to be a strong predictor of outcome in our busy stroke center setting.

Key Words: CT perfusion, stroke

Electronic Scientific Exhibit 45
Applications of Mechanical Embolectomy in Acute Stroke Management: Technique and Usefulness of Device in a Busy Stroke Center
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Purpose
Mechanical embolectomy has made a huge impact in the treatment of acute strokes. The goal of our project is to introduce clinicians and interventionalists to the advances of
interventional procedures available for use in acute stroke patients. Another aim of this project is to teach our colleagues who may be reluctant to implement this technology in their practice as they are unfamiliar with its benefits and pitfalls.

**Approach/Methods**
We have treated well over 200 patients with mechanical embolectomy at our institution. Our experienced faculty will be able to provide a step-by-step description of use of embolectomy device, as well as an interactive decision-making algorithm in the applicability of device as illustrated by selected case models. As mentioned, the benefits and pitfalls of this technology will be addressed in this exhibit.

**Findings/Discussion**
Interactive electronic exhibit with which clinicians can learn the applications of embolectomy devices, learn procedural techniques, and appreciate the usefulness of the technology as demonstrated in selected case models.

**Summary/Conclusion**
This exhibit illustrates the shift of treatment paradigm in acute stroke management with the availability of mechanical devices that are able to extract and/or disrupt clot formation within proximal intracranial vessels.

**Key Words:** Mechanical embolectomy, stroke

**Electronic Scientific Exhibit 46**
**Mesh Generation for Finite Element Analysis from Cross-Sectional Neuroimaging Data**

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**Purpose**
Advances in image postprocessing have made multiplanar reformatting and 3D volume rendering routine in modern practice. The next generation of image postprocessing software may support, in addition to volume rendering, the option of 3D finite element analysis (FEA) to evaluate clinical problems such as aneurysmal blood flow, cerebrospinal fluid flow obstruction and cerebral elastic deformation. As the process of mesh generation is more complex than statistical parametric segmentation and volume rendering, making FEA a clinical reality requires efficient and powerful mesh generation to be incorporated into postprocessing algorithms. Our method of mesh generation, developed for dynamic studies of CSF motion, is outlined herein including the graphical representation of intermediate steps and appropriate source code.

**Approach/Methods**
Axial T1- and T2-weighted MRI data of 1 mm slice thickness was used as a basis for our analysis, though all cross-sectional modalities and sequences are equally practical. The ventricular CSF compartment was selected on each slice with ROIs using the PACS application OSIRIX. These modified images then were exported in JPG format and the CSF space segmented using a parametric intensity dependent algorithm in MATLAB. Contour plots of the resulting spaces were created in MATLAB and random points selected for the basis of FEA mesh generation. The data set was exported for each slice into the advanced CAD modeling package SolidWorks, where they were integrated together into a single CAD model and exported into the professional finite element solver COMSOL multiphysics for mesh conversion and subsequent mechanical and/or fluid dynamics simulations.

**Findings/Discussion**
The operator-dependent portion of our FEM generation algorithm requires that the ventricular system be manually separated from the basal cisterns and choroid fissures by ROIs to prevent their inclusion in the final CSF space. The described segmentation algorithm and contour plots then are capable of reproducing the ventricular perimeter, random points from which may be used for the generation of the final mesh. As the number of points randomly chosen per unit length of ventricular perimeter increases linearly, the number of mesh elements and therefore mesh complexity increases exponentially. While the points on each plane are easy to unite by either spline or linear interpolation, the mesh lines between planes must at present either be made manually or with a loft function. The loft functions, contained in MATLAB and SolidWorks, create artifacts at structural bifurcations, particularly at the inferior boarder of the lateral ventricles, as demonstrated. Liner point integration, conversely, avoids this problem but results in a discretized final geometry contour, which only may be neglected computationally if the mesh element size is sufficiently small.

**Summary/Conclusion**
Our method provides a semiautomated means of generating geometrically accurate finite element meshes of complex biological geometries. We have used the ventricular system of the adult brain as a typical example of a complex biological structure, but the proposed method is equally applicable to vascular studies and cerebral parenchymal elasticity analysis.

**Key Words:** Ventricles, mesh, finite elements

**Electronic Scientific Exhibit 47**
**All that Jazz: The Sellar Region: A Review of Anatomy and Pathology**

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**Purpose**
1) Review the gross and imaging anatomy of the sella, suprasellar and parasellar regions; 2) Review imaging characteristics and patterns of disease spread of common and uncommon abnormalities; 3) Learn a systematic approach for the evaluation of the sella, suprasellar and parasellar regions.
**APPROACH/METHODS**
We reviewed the imaging studies of more than 300 cases with lesions in the sellar region performed at three major institutions over a 4-year period. The cases were analyzed with regard to the presence of calcification, cyst formation, enhancement pattern, bone remodeling or destruction, location with respect to the sella, and clinical presentation. Abnormalities were grouped into disease categories and the data acquired were used to develop an imaging algorithm.

**FINDINGS/DISCUSSION**
Abnormalities included granulomatous (sarcoid, TB, histiocytosis), neoplastic (pituitary microadenoma and macroadenoma, meningioma, metastatic disease, pituitary carcinoma, optic glioma, hypothalamic glioma, hamartoma of the tuber cinereum, teratoma, craniopharyngioma, and chondrosarcoma), developmental (arachnoid cyst, lipoma, Rathke’s cleft cyst) and vascular (aneurysm) etiologies. The following table is a preliminary summary of our findings and will be used as part of an image interpretation algorithm.

<table>
<thead>
<tr>
<th>Disease Category</th>
<th>Cyst</th>
<th>Enhancement</th>
<th>Bone Remodeling</th>
<th>Bone Destruction</th>
<th>Sellar Remodeling</th>
<th>Sellar Destruction</th>
<th>Para-sellar Remodeling</th>
<th>Supra-sellar Remodeling</th>
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<tbody>
<tr>
<td>Vascular</td>
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<td>Granulomatous</td>
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<tr>
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</tbody>
</table>

* Disease categories will be further divided into individual diseases.  
** Enhancement will be further divided into delayed, peripheral, eccentric, and homogeneous.

**SUMMARY/CONCLUSION**
This computer interactive module will facilitate the development of a systematic approach for image analysis and the formulation of a differential diagnosis for lesions in this region.

**KEY WORDS:** Sella, analysis, imaging

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**Electronic Scientific Exhibit 49**  
**Imaging of Salivary Glands**  
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**PURPOSE**
To describe and illustrate the normal anatomy and various pathologies involving the salivary glands.

**APPROACH/METHODS**
We retrospectively studied 63 patients from our archive system with various salivary gland pathologies. The diagnostic images (CT, USG, MRI and plain radiography) of these patients serve the basis of this exhibit.

**FINDINGS/DISCUSSION**
The salivary tissue can be affected by a variety of pathologic processes. For the purpose of this exhibit we classify these pathologies in two major categories: nonneoplastic and neoplastic. Nonneoplastic are further divided into a) infection (acute/chronic) b) obstructive and trauma, c) systemic and d) cystic lesions. Neoplastic are classified into epithelial and nonepithelial tumors. Pathologies involving the parotid, submandibular and sublingual glands are presented.

**SUMMARY/CONCLUSION**
In this exhibit we present typical and atypical imaging features of nontumoral and tumoral lesions of the salivary gland with diagnostic “pearls” to their diagnosis.

**KEY WORDS:** Salivary gland, tumors

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**Electronic Scientific Exhibit 50**  
**Know Your Nodes: A Review of Cervical Lymph Node Anatomy**  
McGinty, K. A. · Woldenberg, R.  
North Shore University Hospital  
New York, NY

**PURPOSE**
The purpose of this exhibit is to: 1) Review the nodal anatomy and lymphatic drainage pathways of the neck; 2) Review the pathophysiology and appearance of abnormal neck nodes; and 3) Discuss management implications of abnormal nodes in the head and neck cancer patient.

**APPROACH/METHODS**
Learning the anatomy and pathology of the lymph nodes of the neck is often a formidable task for even the most experienced radiologist. We intend to review the anatomy and lymphatic drainage of level I - VII cervical lymph nodes as well as the parotid, retropharyngeal, occipital, mastoid and suprACLAVICULAR lymph node groups as well as the anatomical boundaries which define these groups.
Electronic Scientific Exhibits

**HEAD AND NECK**

**INDICATIONS**

We will present the abnormal imaging findings in commonly encountered pathology of the head and neck. We also will discuss the relevance of abnormal nodes which will be presented with attention to surgical management implications in the head and neck cancer patient.

**SUMMARY/CONECLUSION**

The major teaching points of this exhibit are: 1) To provide a comprehensive review of the anatomy and lymphatic drainage of the nodal groups of the neck; 2) To review the appearance and causes of abnormal lymph nodes in the various nodal groups; and 3) To summarize the implications of abnormal nodes in surgical management of the head and neck cancer patient.

**KEY WORDS**: Anatomy, cervical, nodes

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**Electronic Scientific Exhibit 52**

**Road Rules: Imaging Evaluation of Lesions in the Thoracic Inlet**

**PURPOSE**

This computer-based teaching module will: 1) Review the anatomy of the thoracic inlet; 2) Review the clinical and radiographic findings of lesions encountered in this region; and 3) Illustrate common pathways of disease spread.

**APPROACH/METHODS**

A retrospective review of 94 cases of thoracic inlet pathology from the head and neck case files of four institutions was performed. These cases were analyzed with regard to clinical presentation, location, and patterns of disease spread. Pathologic correlation and clinical follow up were available in most cases to confirm the etiology and extent of disease. Imaging evaluation algorithms for lesions in the thoracic inlet (either space or organ specific) were developed based on this analysis.

**FINDINGS/DISCUSSION**

The thoracic inlet is an area that is under-emphasized in the training of residents and fellows. Thus, imaging evaluation of cases in this region is often less than optimal. The thoracic inlet is a busy intersection between the neck and the chest, containing a number of structures from several organ systems (respiratory, gastrointestinal, neural, endocrine, vascular, and lymphatic). An understanding of the anatomy of the spaces in the neck that cross the thoracic inlet (carotid, visceral, danger and prevertebral) and the location of key neural and vascular structures is important when evaluating pathology in this region. Lesions in the various spaces will be illustrated: carotid space (carotid and venous thrombosis, aortic dissection with extension into the carotid artery), pretracheal portion of the visceral space (thyroid lesions, infections, and central airway pathology (i.e., tracheal stenosis, sabre-sheath trachea, tracheoceles, and Mounier-Kuhn syndrome), and retropharyngeal and danger spaces (infection). Additional esophageal, congenital, neoplastic and neural lesions in this region will be reviewed.
Role of Ultrasonography in Predicting Benignity and Determining Fine Needle Aspiration Indication in Nonpalpable Thyroid Nodules Sized 1-2 cm

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Seoul, REPUBLIC OF KOREA

PURPOSE
To find ultrasonographic features predicting benignity in nonpalpable thyroid nodules sized 1-2 cm and their reliable guidelines for fine needle aspiration (FNA).

APPROACH/METHODS
Our study was approved by our institutional review board and written informed consent was waived. Between April 2004 and June 2006, screening ultrasonography was performed for 16,352 self-referred patients in the health care center. Fine needle aspirations were performed on 1,325 thyroid nodules in 1,009 patients. Pathologic results of FNA revealed that 823 benign, 154 indeterminate, 198 nondiagnostic, and 150 malignant nodules. Among them, nonpalpable nodules sized 1-2 cm were selected. Seventy-two benign nodules (confirmed by both FNA and follow up over 1 year) in 67 patients and 51 malignant thyroid nodules (confirmed by FNA with or without thyroidectomy) in 48 patients finally were included. Three radiologists retrospectively analyzed presence of characteristic ultrasonographic features previously known as benign (rim or arc calcification, spongiform, hypoechoic rim) or malignant (marked hypoechoegenecity, punctate calcification, well defined spiculated margin, taller than wide shape, irregular shape). They also analyzed presence of equivocal ultrasonographic features (isoechoegenecity and coarse calcification).

FINDINGS/DISCUSSION
Isoechoegenecity, spongiform and hypoechoic rim were significant predictors for benignity while marked hypoechoegenecity, punctate calcification, well defined spiculated margin, taller than wide shape, irregular shape and coarse calcifications were for malignancy (P < 0.05). However, rim or arc calcification was indeterminate feature (P = .025). When one or more malignant ultrasonographic features were observed, the positive and negative predictive values for malignancy were high, which were 94.8 and 90.7 respectively. When one or more benign ultrasonographic features were observed in a thyroid nodule without malignant or indeterminate features, the positive and negative predictive values for benignancy were high, which were 98.4 and 82.0 respectively.
asymmetry. In the inflammatory/infectious category we present sclerosing osteomyelitis of Garre as well as biphosphonate related osteonecrosis of the jaw (BRONJ). Vascular entities include hemangioma and AVM, and we also show a nonvascular soft tissue lymphangioma. Treatment decisions depend on many factors. 2D and 3D MDCT reformats can help establish whether the lesion is well encapsulated (enucleation and curettage) or has more diffuse involvement. A high risk of recurrence may necessitate block or segmental resection with more aggressive treatment. Dentascan can help depict adjacent anatomical landmarks and guide placement of implants. Reconstructive surgery is geared towards stabilization, functionality and aesthetics.

**SUMMARY/CONCLUSION**

Lesions of the mandible and maxilla often resemble one another and present a unique diagnostic challenge. Careful consideration of clinical and radiographic indicators, with the aid of MDCT reconstructions, can help narrow the differential and guide the surgeon in appropriate management.

**KEY WORDS:** Mandible, maxilla, MDCT

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**Electronic Scientific Exhibit 55**

**Middle Ear Ossicles: Optimum Imaging Planes and Pathology**

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Mayo Clinic
Rochester, MN

**PURPOSE**

To review the various causes of middle ear ossicular pathology. The advantages of volumetric CT to optimally image the pathology will be emphasized.

**APPROACH/METHODS**

The data base of about 100 patients with middle ear ossicular pathology is interrogated for classification and demonstration of various pathologic conditions that affect middle ear ossicles.

**FINDINGS/DISCUSSION**

Improved depiction of ossicular integrity will provide the surgeon with critical information with which to plan his or her surgical approach and anticipate the type of ossicular reconstruction necessary to restore the patient’s conductive hearing. The exhibit will emphasize the importance of oblique multiplanar reformations in the plane of the ossicles to improve detection of ossicular pathology. The optimum imaging planes are illustrated to demonstrate the anatomical details of middle ear ossicles. Oblique coronal planes along the malleus and incus provide the best depiction of these ossicles and incustapedial joint. The oblique sagittal plane allows visualization of the long axis of the malleus and incus and provides an alternative to the axial plane for assessment of the incudomalleal joint. A double oblique orientation of the axial reconstruction plane enables the display of both crura and stapedial foot plate at the oval window. The exhibit will highlight Ossicular fracture/dislocation in the setting of skull base trauma, inflammatory disease causing ossicular erosion from cholesteatoma or fixation from tympanosclerosis, congenitally malformed ossicles (syndromal and nonsyndromal), stapes fixation in the setting of fenestral otosclerosis and many other ossicular pathology.

**SUMMARY/CONCLUSION**

This education exhibit will illustrate the optimum imaging planes and pathologic conditions which affect middle ear ossicles.

**KEY WORDS:** Middle ear ossicles, pathology, imaging planes

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**Electronic Scientific Exhibit 56**

**Craniosynostosis**

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Hershey, PA

**PURPOSE**

The purpose of this exhibit is to illustrate the routine and 3D imaging findings of various craniosynostosis (CS). Identify the associated intracranial and facial abnormality and effect depending on the type of craniosynostosis.

**APPROACH/METHODS**

We retrospectively reviewed the images from our archive system of 33 patients with craniosynostosis, which formed the basis of this exhibit. All 33 patients underwent thin section CT scan followed by 3D CT reconstruction with shaded surface reconstruction. Radiographic diagnosis of craniosynostosis is based on the relationship between the sutures and cranial shape. Besides thin section CT we used a surface rendering algorithm to demonstrate the characteristic cranial shape which was found to be extremely helpful for the pediatric neurosurgeon in defining their surgery and follow up.

**FINDINGS/DISCUSSION**

Plain radiography, and routine CT has been used widely for imaging the craniosynostosis. However, their role appears to be limited especially while deciding for surgery. Thin section CT and 3D volume rendering improves the diagnostic information and result of various surgeries performed. Though the bony changes are best identified by CT the underlying brain anomalies and effects were best analyzed by MRI. For the purpose of this exhibit we have classified the craniosynostosis into primary CS which is due to primary defect of ossification (e.g., scaphocephaly, plagiocephaly, brachycephaly and trigonocephaly) and secondary CS which is due to failure of brain growth. We also present the normal development of the cranial vault, sutural anatomy and physiologic fusion.

**SUMMARY/CONCLUSION**

Exhibit will illustrate the normal sutural anatomy and physiologic variations and fusions. This presentation will also illustrate craniosynostosis classification, pathophysiology and associated intracranial anomalies.

**KEY WORDS:** Craniosynostosis, 3D CT
Electronic Scientific Exhibit 57

Imaging of Perineural Spread in Head and Neck Malignancies

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PURPOSE
Perineural spread (PNS) is a common growth pattern for different types of the head and neck malignancies. It is also one of the common causes of recurrence. Recognizing the pattern of PNS by neuroradiologists is important as radiology may be the only evidence of malignancy and it may often precede clinical symptoms. Imaging at high field strength magnets, thin sections with high resolution and fat suppression now allow earlier diagnosis of this entity. But even with these imaging developments, familiarity with the relevant anatomy and the subtle alterations on MRI are necessary to identify this important condition. We will review all these aspects of PNS in this educational exhibit.

APPROACH/METHODS
We retrospectively reviewed the imaging findings in patients with proved head and neck malignancies and evidence of PNS on clinical examination and imaging over the last 4 years at our institutions. Our preferred MRI protocol for patients with suspected PNS applied thin (2-3 mm) section T1, T2 and postcontrast-enhanced T1-weighted images (WI) with and without fat suppression in axial and coronal planes and with a field of view of 16 to 18 cm. Precontrast T1 WI was important to look at involvement of the normal fat planes. Fat suppressed postcontrast T1 WI was important to look at subtle enhancing lesions, which would otherwise be missed on routine postcontrast T1 WI. CT was ideally performed with 1.25 mm sections through the suspected region of abnormality and the images were viewed in both soft tissue and bone algorithms.

FINDINGS/DISCUSSION
The second (V2) and third (V3) divisions of the trigeminal nerve and the descending (mastoid) segment of the facial nerve were the most commonly involved pathways of PNS due to their extensive subcutaneous distributions in the head and neck. However, we also observed PNS along other less frequently associated nerves like the ophthalmic division (V1) of trigeminal, auriculotemporal and inferior alveolar branch of mandibular nerve, nerve of the Vidian canal, and greater superficial petrosal and tympanic branches of the facial nerve. Typical imaging findings on CT scan were foraminal enlargement, foraminal destruction, and abnormal enhancement within the foramen or canal. MRI findings suggestive of PNS were obliteration of fat planes around the nerve or within the foramen, nerve enhancement, and nerve enlargement. With spread of disease to the cavernous sinus, there was convexity of the lateral cavernous sinus wall and with tumor spread to the trigeminal cistern (Meckel’s cave), there was replacement of normal CSF signal by enhancing soft tissue.

SUMMARY/CONCLUSION
Perineural spread from head and neck malignancies is a serious complication associated with local recurrences and decreased patient survival. Imaging is critical in these cases, but missed diagnosis is common. Accurate detection of PNS requires precise understanding of the anatomy and pathology of the commonly involved neural pathways. A high level of suspicion on the part of the clinician and radiologist, awareness of common imaging signs of PNS, and careful attention to imaging technique will allow earlier detection.

KEY WORDS: Perineural spread, head and neck, malignancies

Electronic Scientific Exhibit 58

Cone Beam CT in Maxillofacial Imaging

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PURPOSE
The purpose of this exhibit is to highlight the emerging role of cone beam computed tomography in maxillofacial imaging and illustrate with multiple, characteristic images. Cone beam CT (CBCT) is a versatile emerging technology whose high and isotropic spatial resolution, undistorted images, compact size and relatively low cost, make it a perfect candidate for a dedicated dentomaxillofacial imaging modality.

APPROACH/METHODS
Cone beam technology utilizes x-rays much more efficiently, requires far less electrical energy, and allows for the use of smaller and less expensive x-ray components than fan beam technology. Because the head and neck can be stabilized sufficiently for clear imaging at a slower scanning speed, a dedicated dentomaxillofacial scanner does not require the highly sophisticated, bulky, and expensive components required for subsecond scanning in full-body CT. In short, CBCT is ideally suited for high quality and affordable in-house or on-site CT scanning of the head and neck in dentomaxillofacial applications.

FINDINGS/DISCUSSION
The advent of CBCT technology has paved the way for the development of relatively small and inexpensive CT scanners dedicated for use in dentomaxillofacial imaging. Cone beam CT can provide dentomaxillofacial practitioners with a complete solution for performing specific diagnostic and surgical tasks, such as dental implant planning. Cone beam CT, which reproduces multiple images including axial, coronal and sagittal planes of the joint, provides a complete radiographic investigation of the bony components of the temporomandibular joint (TMJ). The exhibit will display representative images illustrating TMJ conditions such as osteoarthritis, presurgical evaluation of dental implants, facial fractures, jaw tumors as well as use of CBCT in evaluation of dental and periodontal disease.
**SUMMARY/CONCLUSION**

Application of cone beam CT in maxillofacial imaging is a relatively new, emerging technology. This exhibit will provide the practicing radiologists an opportunity to become familiar with this technique with the use of illustrative images.

**KEY WORDS:** Cone beam CT, maxillofacial, imaging

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**Electronic Scientific Exhibit 59**

**Orbital Imaging: Clinical Case Presentations and Differential Diagnosis**

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Imaging differential diagnosis of orbital pathology is made easier by identifying the abnormality within a designated compartment. Based on patient demographics and pertinent imaging characteristics this differential can be further refined. The following presentation is a series of case centered differential diagnoses of orbital pathology defined by a specific compartment. Relevant imaging findings for diagnosis within the spaces defined by the optic nerve, retro-orbital intra and extracanal regions, the bony orbit and anterior compartment are described.

**KEY WORDS:** Orbit

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**Electronic Scientific Exhibit 60**

**Diffusion-Weighted Imaging of Scalp and Skull Lesions**

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**PURPOSE**

Diffusion-weighted imaging (DWI) recently has been included as a standard brain MR sequence. The imaging findings of scalp and skull lesions are often nonspecific, and include various benign and malignant pathologies. We demonstrate the value of DWI in tailoring the differential diagnosis of scalp and skull lesions.

**APPROACH/METHODS**

We have collected DWI studies in over 100 patients with scalp and skull lesions. These include skull metastasis, diffuse bone marrow infiltration of leukemia, skull invasion of primary brain tumor, subgaleal or subperiosteal abscess, Pott's puffy tumor, mucocle, cholesteatoma, mastoiditis with sinus thrombosis, mastoid abscess, subgaleal or subperiosteal hematoma, subcutaneous or intraosseous epidermoid cyst, fibrosseous disease, intraosseous meningioma, hemangioma and other benign and malignant scalp lesions.

**FINDINGS/DISCUSSION**

Diffusion-weighted imaging with its inherent fat saturation enhances the conspicuity of the scalp and skull lesions with nulling of the scalp fat. Diffusion-weighted imaging demonstrates characteristics unique to certain etiologies, particularly abscesses, hypercellular tumors, diffuse leukemic bone marrow infiltration epidermoids and cholesteatoma.

**SUMMARY/CONCLUSION**

In this exhibit, we illustrate DWI findings of scalp and skull lesions in tailoring the differential diagnosis.

**KEY WORDS:** Diffusion-weighted, scalp, skull

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**Electronic Scientific Exhibit 61**

**Use of Iterative Decomposition of Water and Fat with Echo Asymmetry and Least Squares Estimation Fat Suppression Technique in Imaging of the Orbits, Head and Neck**

Grayev, A. M. · Gentry, L. · Reeder, S.
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Madison, WI

**PURPOSE**

To investigate the use of iterative decomposition of water and fat with echo asymmetry and least squares estimation (IDEAL) fat suppression technique in imaging of the orbits, head and neck.

**APPROACH/METHODS**

Fast spin-echo IDEAL images were reconstructed with an on-line reconstruction algorithm, which provides separate water, fat and recombined in-phase (water + fat) and out of phase (water - fat) images. Traditional chemical shift and fast spin-echo IDEAL fat suppressed images were reviewed in 15 patients with various types of orbital, head and neck pathology to compare the adequacy of fat suppression by the two methods. The presence of susceptibility artifacts and image sound to noise ratio (SNR) also were assessed.

**FINDINGS/DISCUSSION**

IDEAL fat suppression was considered superior to traditional chemical shift fat suppression in all patients. IDEAL fat suppression was more uniform with less susceptibility artifact, particularly when fat was adjacent to air, calcification, metal or implanted surgical material. Fast spin-echo IDEAL images also demonstrated high SNR and superior image
quality. Image 1 demonstrates an enhancing intraconal soft tissue mass with poor suppression of the intraconal fat. Image 2 demonstrates the same lesion using IDEAL technique with improved suppression of the intraconal fat.

**SUMMARY/CONCLUSION**

Fast spin-echo IDEAL imaging provides homogeneous fat suppression throughout the orbits, head and neck without significant susceptibility artifact while maintaining a high SNR.

**KEY WORDS:** Orbit, head and neck
At the end of this review, the viewer should have a better understanding of the physiopathology of the trigeminal pathways and be able to better correlate the clinical manifestations as they relate to the imaging findings.

**Key Words:** Trigeminal pathways

### Electronic Scientific Exhibit 64

**Vascular Lesions of the Temporal Bone**

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Birmingham, AL

**Purpose**

We present a review of various vascular lesions of the temporal bone.

**Approach/Methods**

We reviewed our case archives for patients who had vascular lesions involving the temporal bone. Images were reviewed and the most representative images demonstrating the lesion in question were chosen. Computed tomography (CT), MRI and catheter angiographic images were reviewed. Additionally, we performed 3D volume rendered, MIP and multiplanar reformations on an Aquarius 3D workstation (Terarecon) to demonstrate the anatomical relationships of the lesions. A selection of our cases includes: Internal carotid artery agenesis, aberrant course of the petrous internal carotid artery, Persistent stapedial artery feeding a dural arteriovenous (AV) fistula, high riding jugular bulb, petrous carotid aneurysm, dural AV fistula involving the temporal bone, enlarged subarcuate artery, prominent arterial loops causing pulsatile tinnitus, posterior fossa developmental venous anomaly draining into a venous lake in the temporal bone.

**Findings/Discussion**

Vascular lesions in the temporal bone are uncommon and their detection and diagnosis can be challenging. A good working knowledge of the anatomy of the temporal bone and a thorough analysis of the images with clinical correlation is essential to the diagnosis.

**Summary/Conclusion**

We would like to submit an electronic scientific exhibit of some of the vascular lesions in the region of the temporal bone. We believe that a review of these uncommon lesions will be of educational value.

### References


### Electronic Scientific Exhibit 65

**Advanced Imaging Anatomy of the Pterygopalatine Fossa**

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New York, NY

**Purpose**

The pterygopalatine fossa (PPF) is important as a pathway for the spread of tumor and infection, as well as containing collateral routes between the intracranial and extracranial circulation. In the setting of a maxillary osteotomy, it is important for presurgical planning because bleeding from the maxillary artery and its branches is an issue. Due to the difficulty in both the surgical and imaging evaluation of this region, demonstration of anatomical variations and of pathology involving this area has been limited. With the increasing availability of high performance gradients and high field strength magnets, the ability to detail the precise soft tissue anatomy of the PPF is feasible. In neurologic imaging, balanced steady state free precession type sequences, such as fast imaging employing steady state acquisition (FIESTA), have been used traditionally to evaluate fluid filled structures. Fat within the pterygopalatine fossa also has high signal on FIESTA imaging and provides excellent contrast for the structures coursing through it. This allows for the novel possibility of using this sequence to identify the individual arteries and nerves within this space. Incorporating both conventional and more advanced imaging modalities the detailed anatomy of the pterygopalatine fossa and its clinical importance will be reviewed.

**Approach/Methods**

The anatomy of the pterygopalatine fossa is presented using multiple formats and imaging modalities, including schematics, plain films, high resolution CT, 3D reconstructions of CT images, angiography, and conventional MR images. Additionally, MR images of nondiseased pterygopalatine fossas performed on a 3T MR scanner using FIESTA pulse sequences also were evaluated. This sequence benefits from fast acquisition times, high resolution, and high contrast images that allow for the identification of individual arteries and nerves.

**Findings/Discussion**

The PPF is a fat-filled space that is nearly completely surrounded by bone. Shaped like an inverse pyramid, it represents a central intersection for both vascular and nervous structures. It has connections to the oral cavity, orbital apex, nasal cavity, infratemporal fossa, and middle cranial fossa. The osseous anatomy has been well described and is reviewed pictorially using CT and reconstructed images. The contents of the fossa including the pterygopalatine ganglion, ramifications of the maxillary division of the trigeminal nerve, as well as branches of the distal internal maxillary
artery are definable on the MR images. The anatomy of the contents are reviewed and delineated on the imaging studies. The visualized vessels include the sphenopalatine artery, palatine artery, pterygoid artery, and infraorbital artery. Finally, cases of pathology relevant to this anatomically complex area are reviewed.

**SUMMARY/CONCLUSION**

The pterygopalatine fossa is a complex hub of vessels and nerves whose contents in individual patients have been difficult to evaluate either surgically or with imaging. We present a comprehensive review of the anatomy of the pterygopalatine fossa and its contents as well as cases of pathology involving this region. Advances in MR imaging technology promise the possibility of more detailed imaging of this space, thereby increasing sensitivity for detection of relevant pathology and improving surgical planning.

**KEY WORDS:** Pterygopalatine fossa, anatomy, FIESTA

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**Electronic Scientific Exhibit 66**

Withdrawn

**Electronic Scientific Exhibit 67**

Withdrawn

**Electronic Scientific Exhibit 68**

Rhinorrhoea: Detection with MR Cisternography and 3D-CISS Sequence

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Uludag University School of Medicine

Bursa, TURKEY

**PURPOSE**

The aim of study was to establish and to evaluate non-gadolinium-enhanced MR cisternography and gadolinium-enhanced MR cisternography after intrathecal Gd-DTPA administration to detect rhinobasal cerebrospinal fluid (CSF) fistulae in patients with suspected CSF rhinorrhoea.

**APPROACH/METHODS**

The MR cisternography included the following investigation steps: initially, nonenhanced coronal, axial, sagittal fat-suppressed T1-weighted spin-echo and coronal, sagittal non-gadolinium-enhanced MR cisternogram [3D-constructive interference steady-state (CISS)] images were obtained in the prone position. After lumbar puncture with administration of 1 ml Gd-DTPA same fat-suppressed T1-weighted sequences used again.

**FINDINGS/DISCUSSION**

In 14 patients with suspected CSF rhinorrhoea 3D-CISS detected six CSF fistulae. In three of six CSF leaks were located in the cribriform plate and in three of six sphenoidal. No leakage was observed in eight patients. Gadolinium-enhanced MR cisternography detected eight CSF fistulae. In four of eight CSF leaks were located in the cristafriform plate and in four of eight sphenoidal. Whereas six of these depict-ed leaks were confirmed surgically, in two cases the CSF fistula closed spontaneously. No leakage was observed in six patients. Gd-DTPA injection was tolerated excellently. Clinical examinations showed no gross behavioral or neurologic disturbances and no seizure activity, respectively.

**SUMMARY/CONCLUSION**

The MR cisternography after intrathecal administration of Gd-DTPA represents a safe, promising and minimally invasive method for detection of CSF fistulae. This MR investigation provides excellent depiction of CSF spaces and pinpoint CSF fistulae. We also recommend the combination of gadolinium-enhanced MR cisternography scans followed by 3D-CISS (nongadolinium-enhanced MR cisternography) sequence as the optimal imaging approach for these patients.

**KEY WORDS:** CSF rhinorrhoea, MR cisternography, gadolinium

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**Electronic Scientific Exhibit 69**

MR and CT Imaging Findings of Calcium Pyrophosphate Dihydrate Deposition Disease at the Craniovertebral Junction

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**PURPOSE**

The purpose of this exhibit is to illustrate imaging of calcium pyrophosphate dihydrate (CPPD) deposition disease at the craniovertebral junction (CVJ), specifically around the odontoid process, discuss imaging features that may differentiate CPPD deposition in this location from various mimics, and describe symptoms associated with this disease.

**APPROACH/METHODS**

The CT and MR imaging of 26 patients with pathologically proved CVJ CPPD requiring neurosurgical intervention were reviewed retrospectively to clarify a pattern of findings and symptoms associated with this disease. Imaging of patients presenting with similar histories and non-CPPD imaging findings at the CVJ were evaluated also to determine features that may help differentiate these mimics.

**FINDINGS/DISCUSSION**

The deposition of calcium pyrophosphate dihydrate at the craniovertebral junction can cause a variety of symptoms, including significant neck pain or stiffness, cervical myelopathy, extremity numbness or weakness, urinary incontinence, imbalance and dysphagia. Retrospective analysis of 26 cases demonstrating CPPD at the craniovertebral junction allowed for clarification of specific imaging findings of this disease. On MR examination, cases of proved CPPD demonstrated a predominantly isointense mass around the odontoid process on T1-weighted images, and variable intensity mass on T2-weighted images. On post-gadolinium T1-weighted images, peripheral or heterogeneous enhancement was visualized around the mass. On CT images, the presence of calcifications within the mass, and erosive changes involving the adjacent bone were often present. Subluxation and/or fractures at the site of the
involvement can be seen also on both CT and MR imaging. A constellation of these findings can help differentiate CPPD from other similar CVJ lesions such as rheumatoid arthritis, gout, or hydroxyapatite crystal deposition, as well as trauma or neoplasm. Many of these mimics also are more likely to demonstrate greater enhancement.

**SUMMARY/CONCLUSION**
A diagnosis of CPPD at the craniocervical junction, although rare, can be important in determining appropriate patient management. While the range of symptoms may vary, knowledge of characteristic imaging findings of CPPD can help raise the possibility of this disease for the surgeon and the pathologist, and ensure definitive diagnosis by polarized light microscopy. This retrospective review clarifies common imaging findings that, even if not always distinguishable from mimics, can aid in raising the suspicion of symptomatic CVJ CPPD.

**KEY WORDS:** Calcium pyrophosphate dihydrate deposition disease, pseudogout, craniovertebral junction

**Electronic Scientific Exhibit 70**
Review of Principles of MR Imaging of Solutions Containing Increasingly High Concentration of Protein and Its Significance in Imaging of Inflammatory Sinonasal Diseases

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Birmingham, AL

**PURPOSE**
The MR signal characteristics of a protein solution depend primarily upon the water content and protein concentration of the solution. Pure water has a very long T1 and T2 relaxation and appears as hypointense in T1-weighted images (T1WI) and hyperintense in T2-weighted images (T2WI). With increasing protein concentration of a solution, the T1 relaxation gradually slows to a particular point (Larmor frequency) after which the T1 relaxation becomes less efficient (as the tumble frequency of the system slows). Conversely, with increasing protein concentration of solution, there is increasingly faster T2 relaxation until it reaches a plateau when the solution becomes viscous or solid. With increasing protein concentration, T1 signal intensity initially increases and then starts decreasing, ultimately reaching signal void. When the T2 relaxation is excessively short, this effect dominates any observed T relaxation, and signal voids are observed also in T1-weighted images, the T2 effect on the T1 relaxation time. In T2WI, there is continuous drop of signal (which can not be appreciated initially) and ultimately there is signal voids when the solution becomes semisolid/solid. With chronic sinonasal obstruction, there is increasingly high protein secretion due to Goblet cell metaplasia of the sinus mucosa, reabsorption of water from the secretion and decrease turnover of the mucoprotein and the secretion ultimately becomes viscous and desiccated. In this stage, there are signal voids in both T1WI and T2WI.

**Approach/Methods**
T1- and T2-weighted MR images and noncontrast CT (NCCT) scan of the paranasal sinuses of four representative cases were obtained. First Case: Normal. Second Case: Acute sinonasal inflammatory disease. Third case: Subacute sinonasal inflammatory disease. Fourth Case: Chronic sinonasal inflammatory disease. Fifth Case: Fungal sinusitis with very thick secretion. CT scan is compared with T1WI and T2WI of each patients.

**FINDINGS/DISCUSSION**
Results are tabulated.

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<th>T2 (Signal is compared with gray matter)</th>
<th>NCCT (Density is compared with the vitreous)</th>
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<td>4th Case</td>
<td>Isointense</td>
<td>Hypointense</td>
<td>Hyperdense</td>
</tr>
<tr>
<td>5th Case</td>
<td>Signal voids</td>
<td>Signal voids</td>
<td>Desiccated hyperdense secretion</td>
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**SUMMARY/CONCLUSION**
Obstructive inflammatory sinus disease with very high protein containing secretion produce signal voids on both T1- and T2-weighted sequences and thus appear indistinguishable from normal aerated sinus. Often times, evaluation of sinonasal diseases only with MRI severely underestimate the disease and sinonasal MRI should always be interpreted with special care and always with complementary CT scan in suspicious cases.

**KEY WORDS:** MRI, sinusitis

**Interventional 71-72**

**Electronic Scientific Exhibit 71**
Transoral Approach to Image-Guided C2 Interventions

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**PURPOSE**
To describe our initial experience with transoral approach to image-guided interventions on C2 vertebra and its relative advantages and disadvantages.

**Approach/Methods**
We performed five procedures on different types of lesions involving C2, through transoral approach, using CT guidance. All were biopsies and one also included vertebroplasty.

**FINDINGS/DISCUSSION**
The procedures, performed under general anesthesia, were well tolerated by the patients with no complications, immediately as well as at follow up. Some of the expected complications for transoral vertebroplasty described in literature include infection, hemorrhage and cement leak. In our series,
the patient who had vertebroplasty had symptomatic relief of neck pain at 6-month follow up. All the biopsies in our series were technically successful without any minor or major complications. Transoral approach is an established access in spine surgery literature. However, to our knowledge, use of this approach for guided-biopsies has not been described in the available literature.

**SUMMARY/CONCLUSION**
Image-guided transoral approach to interventions on C2 including biopsy is a novel technique, providing direct, safe and precise approach, when performed with appropriate precautions.

**KEY WORDS:** Transoral, vertebroplasty, biopsy
Electronic Scientific Exhibit 73

Imaging of Congenital Malformation of Brain

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PURPOSE
To classify, describe and illustrate various congenital cerebral malformation at various stages of central nervous system development. This exhibit is a comprehensive review of congenital brain malformation.

APPROACH/METHODS
We retrospectively analyzed 193 cases of various congenital malformation of the brain from our institution, which formed the basis of this exhibit. Relevant images were identified to illustrate the wide variety of spectrum of congenital malformation of the central nervous system. Benefits of MRI over CT and USG will be emphasized to classify and distinguish various malformations.

FINDINGS/DISCUSSION
For the purpose of this exhibit we have classified the congenital malformations of the brain into five major categories: 1) Neural tube defect: encephaly, myelomeningocele, herniation through cranial defects (cephaloceles, meningocele), 2) disorders of forebrain induction: holoprosencephaly (alaobar, lobar and semilobar), septooptic dysplasia, arhinencephaly, callosal dysgenesis (partial, complete), 3) malformation of cortical development (proliferation, migration and organization), lissencephalies, polygyria, polymicrogyria, schizencephaly, heterotopias (focal, subcortical and band), 4) cerebellar malformation: agenesis, Joubert syndrome, rhombencephalosynapsis, Dandy-Walker malformation, and 5) Msc: lipoma.

SUMMARY/CONCLUSION
Congenital malformations are encountered frequently in neuroradiology practice. This exhibit is a comprehensive review of the congenital malformation of the brain. We also illustrate the typical and nontypical imaging features of these various malformations with diagnostic “pearls” to their diagnosis.

KEY WORDS: Congenital malformation, MRI

Electronic Scientific Exhibit 74

Brain MR Imaging and Chromosomal Abnormalities

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Florence, ITALY

PURPOSE
To illustrate the diagnostic elements acquired with MRI in order to detect the brain abnormalities in a known chromosomal disorder and to suggest the presence of chromosomal abnormality in a range of brain anomalies or malformations.

APPROACH/METHODS
The genetic disorder causing human disease may be due to: a) a single gene disorder, b) a complex interaction between multigenic disorder, or to c) a chromosomal disorder. A wide range of brain abnormalities may be related to different clinical phenotypes, and different phenotypes may be accounted to aneuploidies (alteration in chromosome number), to deletions or tranlocations in both autosomal or sex chromosomes. The MRI markers of brain abnormalities range from clearly evident malformation, to very subtle anomalies. In those situations the MRI techniques must be precise, specifically directed to evaluation of brain structures like white matter, gray matter (cortex and nuclei signal and volumes), commissural structure (connectivity), and vessels. The chromosomal disorders are the most common cause of disease. Fifty to 75% of all human pregnancies are affected. Most known syndromes are Down syndrome (trisomy 21), Cri du Chat syndrome, Angelman syndrome, Prader Willi syndrome, X fragile syndrome, Williams syndrome, etc. Magnetic resonance studies were performed in 63 children (44 female and 19 male) in 39 known and 24 suspected chromosomal abnormalities. All techniques, conventional, 3D T1 volumetric acquisition, with diffusion, diffusion tensor imaging, tractography, 1H spectroscopy, are performed at 1.5 and 3T (Philips Achieva, Netherlands BV). Prenatal fetal MR imaging also is obtained in five cases.

FINDINGS/DISCUSSION
MR findings may be characterized by micro or macroencephaly, prominent pericerebral CSF spaces, ventriculomegaly, dysmorphic ventricles, rarely hydrocephalus. Focal white matter defects are encountered. Midline abnormalities such as dysgenesis or agenesis of corpus callosum are rarely found (13 cases). Volumetric analysis of corpus callosum may disclose subtle abnormalities. Cortical abnormality and intractable epilepsy may be associated. Posterior fossa malformations are encountered frequently from Dandy Walker spectrum to various degrees of cerebellar hypoplasias. Morphometry may be applied in different regions of brain lobes, basal ganglia or hippocampal regions. DTI and tractography may detect patterns of connectivity that are not normal.

SUMMARY/CONCLUSION
A flow chart of MRI diagnosis of brain abnormalities in chromosomal disorders is suggested in order to help address undefined genetic abnormalities versus correct interpretation of the major and minor findings. In examples of the pseudonodular patchy white matter, hyperintensity is frequently reported in X-linked disorders. The diagnostic difficulty is to understand minimal brain changes in apparently
normal MRIs of the brain that may be underestimated if a genetic disorder is not suspected previously. Normality must be created in order to suggest the necessity of a more specifically directed MRI study.

**Key Words:** Pediatric brain, MRI, chromosomal disorder

**Electronic Scientific Exhibit 75**


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Bridgeport, CT

**Purpose**

To create a simple-to-use, easily accessible, digital atlas of normal pediatric cervical spine CT scans at progressive developmental intervals. For educational purposes, the images are linked to an exhaustive cross-reference of differential diagnoses and a more utilitarian quick-reference of normal values and most common abnormalities for each slice level and each identifiable structure. The studies are organized by age and anatomical location. The images and reference links are formatted for rapid availability in real-time over the Internet.

**Approach/Methods**

A series of normal pediatric CT scans of the cervical spine were collected. A specifically designed authoring program written in Visual Basic and a Microsoft Access Database for data storage were utilized. The studies were organized by series, age, and anatomical location. References to specific anatomy were created. The data and images then were converted through the program into an interactive web program. The web pages utilize DHTML, Vbscript, and Jscript programming languages. Digital versions of leading reference texts, Neuographics, AJNR, Radiographics, AJR, and the PubMed databases were searched utilizing key words relating to all identified structures and modified with the terms “pediatric” and/or “development”. The results were analyzed and appropriate links to associated images were embedded into the program.

**Findings/Discussion**

The final program is easily accessible over the Internet. The user has the ability to switch between axial, coronal, and sagittal reformats. The user can choose a specific anatomical location to focus on. The selected series with the specified anatomy then can be quickly scrolled across age groups. Discussions related to the ossification centers, normal variations, and normal maturation accompanies each selection. The ability to visualize the maturation process with a simple scroll provides a unique perspective not attainable with static images in books or journals. Exhaustive cross-reference and more practically-oriented “quick-reference” augment the educational value of the atlas.

**Summary/Conclusion**

Evaluation of the pediatric CT cervical spine encompasses a high level of complexity and difficulty because of the many ossifications which continually change throughout early development. The Pediatric Spine Atlas will prove itself a useful reference and an important educational tool. The program provides unique features and interactivity that are not possible with books and journals.

**Key Words:** Cervical spine, pediatric, development

**Electronic Scientific Exhibit 76**

**Diffuse Excessive High Signal Intensity: Predicting Neurodevelopmental Outcome in the Preterm Population**

Supsupin, E. P. · Bonfante-Mejia, E. E. · Sitton, C. W. · Vea, R. G. · Parikh, N. · Cacayorin, E. D. · Hochhauser, L
1 University of Texas Medical School at Houston, Houston, TX, 2 Louisiana State University, Shreveport, LA

**Purpose**

Diffuse excessive high signal intensity (DEHSI) is a subtle imaging abnormality of the premature brain displayed by MRI. Cohort studies have shown that up to 50% of very preterm infants suffer from motor cognitive and sensory impairments, many without overt imaging abnormality when imaged at term-equivalent age. Review of recent literature indicates that DEHSI is probably an important predictor of neurodevelopmental outcome of preterm infants who have no recognizable pathology on cranial ultrasound. The purpose of this presentation is to assist radiologists who evaluate MRIs of preterm infants in identifying DEHSI, illustrate its MRI characteristics and discuss its relevance in predicting the neurodevelopmental outcome of preterm infants whose MRI scans are otherwise normal at term equivalent (i.e., infants who show no overt imaging pathology such as intraventricular or parenchymal hemorrhage and periventricular cystic leukomalacia). The prevailing theories on the histopathologic and pathophysiologic basis of the MRI findings will be emphasized.

**Approach/Methods**

MRIs of preterm infants referred for neuroimaging at term equivalent will be presented. The imaging features of DEHSI will be described in detail and the severity of findings will be classified according to published criteria.

**Findings/Discussion**

Diffuse excessive high signal intensity has been reported as a common form of subtle white matter abnormality in up to 75% of infants born less than 30 weeks’ gestation and imaged at the expected term age (term-equivalent). With increasing survival rate of the preterm population, the problem of neurodevelopmental impairment has evolved proportionately. Focal lesions such as hemorrhagic and cystic PVL in the deep white matter correlate well with cerebral palsy. Yet less than 10% of premature infants have cerebral palsy and the majority manifest cognitive and behavioral impairments, even without pathology on cranial ultrasound. The developing cerebral white matter of the premature infant is an extremely vulnerable target for tissue injury. It is postulated that DEHSI represents a neuroimaging correlate of dif-
fuse white matter injury or abnormal development. Although the exact mechanism of DEHSI remains to be elucidated fully, there is mounting evidence that it likely plays an important role as predictor of neurosensory impairment in the preterm population.

**SUMMARY/CONCLUSION**
Evaluation for DEHSI must be incorporated as part of the radiologists’ routine MRI assessment of the neonatal brain of preterm infants. The ability to detect and recognize this important yet subtle white matter abnormality may help physicians initiate early intervention that can potentially impact favorable outcome.

**KEY WORDS:** DEHSI, PVL, premature brain

**Electronic Scientific Exhibit 77**
*Cerebral MR Imaging Evaluation of Preterm Infants: Standardized Assessment and Predicting the Relationship of Common Imaging Abnormalities to Overall Neurodevelopmental Outcome*

Supsupin, E. P. · Bonfante-Mejia, E. E. · Sitton, C. W. · Parikh, N. · Cacayorin, E. D. · Hochhauser, L.
University of Texas Medical School at Houston
Houston, TX

**PURPOSE**
Diagnosis of perinatal brain injury and accurate prediction of neurologic outcome are of the utmost priority to parents and physicians. Identification of infants who are at greatest risk and in need of early intervention is critical. While extensive research is in progress to assess the long-term impact of extra-uterine maturation and signal abnormalities in the cerebrum, radiologists need to become familiar with the appearance of the premature brain. The objective of this presentation is to provide the reader with a pictorial display of normal and abnormal anatomy of the premature neonatal brain, with emphasis on the findings that recent literature has indicated as probable predictors of prognosis.

**APPROACH/METHODS**
Case materials from our institution consisting of consecutive preterm infants referred for neuroimaging will be presented. We illustrate imaging parameters used in assessing cerebral maturation, including cortical infolding, myelination, germinal matrix appearance, and glial cell migration. Examples of signal abnormalities such as diffuse excessive high signal intensity (DEHSI), punctuate white matter lesions (PWML), cystic changes, germinal matrix hemorrhage, intraventricular hemorrhage, cerebellar injury, and periventricular hemorrhagic infarction will be shown.

**FINDINGS/DISCUSSION**
Cranial ultrasound is the current standard but MRI is being performed more frequently in the best medical centers. With its high spatial resolution and ability to depict brain maturation in vivo, MRI has been proposed to emerge as the best imaging tool that will aid physicians in dealing with the difficult task of predicting clinical outcome in the preterm population. Prognostic information is gleaned from brain maturation pattern and the presence of white matter abnormalities. For example, delayed myelination and retarded glial maturation were observed in neurologically impaired infants. Punctuate white matter lesions and DEHSI (Fig), frequently identified in preterm brains recently have gained attention because of their potential role in neurodevelopmental outcome. More sophisticated imaging such as DTI and volumetric MRI provide valuable information about the premature brain; however, these are not readily available in the community. Therefore, optimizing the interpretation of the morphologic findings using conventional MRI sequences is of paramount importance.
SUMMARY/CONCLUSION
The relationship between the risk of neurodevelopmental impairment and qualitative white-matter abnormalities has been documented in numerous outcome studies. An objective, reproducible, and standardized method of MRI evaluation of the preterm brain must be in place as part of our routine evaluation as neuroradiologists. Standardized assessment of brain maturation using published scoring system will help predict long-term neurosensory impairment.

KEY WORDS: Preterm brain, cerebral MRI, DEHSI

Electronic Scientific Exhibit 78

Extremely Preterm Infants: Brain MR Imaging Findings in 45 Cases

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Rio de Janeiro, BRAZIL

PURPOSE
The purposes of this exhibit are to demonstrate the utility of brain MRI on the investigation of extremely preterm infants (weight under 1500g) and, in addition, to illustrate the most common MRI findings in this particular group of patients.

APPROACH/METHODS
A cohort of 45 infants with gestational age (GA) of less than 30 weeks (median of 27 weeks, ranging from 25 to 30 weeks) was studied. The patients had a median birth weight of 890g (ranging from 550g to 1225g). At the corrected term age, the parents gave informed consent to undergo MRI under sedation. All the patients underwent MRI in a 1.5T scanner (Magneton Avanto; Siemens Medical Systems, Erlangen, Germany) using a head coil and standard protocol including T1-, T2- and T2*-weighted images. Two neuroradiologists, who were blinded regarding the clinical data, reviewed independently all the MR images. In cases of disagreement, a third neuroradiologist reviewed the case and the final decision was defined by consensus. Interobserver variability between MR imaging readers was assessed with calculation of the kappa (k) statistic.

FINDINGS/DISCUSSION
Among the 45 studied cases, only four patients (8.9%) had normal MR imaging. The remaining 41 patients (91.1%) presented abnormalities on the MR imaging. The most common findings were: diffuse excessive high signal intensity (DEHSI) in the WM (75.6%), dilation of the ventricles (42.2%), germinal matrix hemorrhage (GMH) (31.1%), IVH (28.9%), ventricular deformities (24.4%) and enlargement of the extracerebral liquor spaces (22.2%). All the kappa values obtained in the analysis of the interobserver variability were statistically significant. The kappa statistic values were high (k > 0.61) for most of abnormal MR imaging findings. However the interobserver agreement was only fair (k = 0.39) for DEHSI in the WM.

SUMMARY/CONCLUSION
Magnetic resonance imaging is useful in evaluating the brain damage in extremely preterm infants, but the myelination patterns at each age have to be observed when reading these exams. The most common MRI findings in this particular group of patients are periventricular areas of high signal on T2-weighted images, hemorrhages and ventricular enlargement. Further studies correlating MRI abnormalities with patient outcome have to be conducted.

KEY WORDS: Preterm infants, MRI, hypoxia

Electronic Scientific Exhibit 79

Midline Nasal Masses of Early Childhood: Embryologic Basis

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Birmingham, AL

PURPOSE
Pediatric midline nasal masses are a group of important closely related pathologies which may present diagnostic challenges. Some of these lesions represent developmental anomalies of anterior neuropore. Some are tumors arising from the normal anatomical structures in this region. Accurate presurgical diagnosis is essential to prevent surgical catastrophes.

APPROACH/METHODS
We present CT and MR imaging features of midline pediatric nasal masses and analyze the diagnostic approach based on embryology.

FINDINGS/DISCUSSION
MR imaging is the modality of choice because of its superior soft tissue contrast and because interpretation of CT is difficult in early stage of craniofacial development. Pitfalls in the CT analysis of this group of diseases include failure to appreciate the pattern of ossification of the craniofacial skeleton at various developmental stages and the resultant variable morphology and size of the foramen cecum. Heavily T2-weighted sequences are particularly helpful to confirm the presence of CSF communication between the mass and the intracranial subarachnoid spaces or ventricles, thereby differentiating nasal heterotopias from encephaloceles. These also demonstrate the distorted morphology of the inferior frontal lobes that may be the only clue to the presence of an otherwise subtle cephalocele. Diffusion-weighted imaging helps to differentiate epidermoids from other pathologies. Postcontrast images are essential for demonstrating enhancement patterns that suggest infection and evaluating other midline entities such as capillary hemangiomas or vascular malformations.

SUMMARY/CONCLUSION
Although midline childhood nasal masses may be diagnostically challenging, analysis of embryology, MR imaging features, and clinical correlation can provide essential clues to the proper diagnosis and management of these lesions.

KEY WORDS: Anterior neuropore, nasal natreotopia, nasal cephalocele
Electronic Scientific Exhibit 80

Normal and Abnormal Embryogenesis of the Spine: Radiographic Findings in Congenital Anomalies of the Spine

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Tripler Army Medical Center
Honolulu, HI

An understanding of the normal embryonic developmental sequence of the pediatric spine is invaluable knowledge to the understanding and differential diagnosis of congenital anomalies of the spine. Subsequently, knowledge of embryology of the spine when combined with the understanding of anatomical relationships in a congenital lesion allows for better differentiation of the time and stage at which the developmental sequence was disrupted. The goal of this exhibit is to familiarize radiologists with the understanding of the spinal congenital malformations and provide an overview of spinal embryogenesis. After reviewing this educational exhibit, the reader will become more comfortable and confident with the diagnosis of congenital anomalies of the spine in a pediatric patient. A computer model will systematically introduce the reader to the normal and abnormal embryogenesis of the spine and delineate the radiographic findings of congenital anomalies within the cervical, thoracic and lumbar spine which can be encountered in both clinical and academic medicine. Some congenital malformations that will be presented include: Coronal Cleft, Craniovertebral Junction anomalies, Myelocoele, Myelomeningocele, Dorsal Dermal Sinus, Dermoid, Intrudural Lipoma, Lipomyelocele, Lipomyelomingocele, Terminal Lipomas, Tight Filum Terminal syndrome, Fibrolipoma, Diastematomeyelia, Caudal Regression syndrome, Sacrococcygeal Teratoma, Syringohydromyelia, Congenital Spinal Stenosis, Segmentation Abnormalities.

KEY WORDS: Spine embryogenesis, congenital spine, pediatric spine

Electronic Scientific Exhibit 81

Imaging Approach to Pediatric Brain Tumors

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PURPOSE
Brain tumors are the most common solid forms of tumors in children and are second only to leukemia in overall prevalence. They constitute about 22% of all malignancies in children. Brain tumors in children have distinctly different etiologies compared to adults and have a myriad of imaging features. In this educational exhibit we summarize the normal and typical imaging features of common pediatric brain tumors and develop an imaging approach towards their differential diagnosis. We also present uncommon imaging features...
findings of these tumors and present some rare tumors with an idea to familiarize the neuroradiologists with the diverse imaging spectrum of this entity.

**Approach/Methods**
We retrospectively reviewed the imaging findings in patients with pathologically proved brain tumors over the last 5 years at our institutions. Imaging modalities included predominantly MR imaging (1.5T, Signa, GE Medical Systems, WI and 1.5T Gyroscan Intera, Philips Medical Systems, Einthoven, The Netherlands) and CT scan in appropriate cases to look for bony anatomy, acute hemorrhage, calcifications and in cases of emergencies.

**Findings/Discussion**
We observed wide spectrum of brain tumors in our patient population. Tumors are classified based on the age of presentation, categorized into intra and extraxial tumors and arising from supra or infratentorial compartments. They are further divided in different anatomical regions like the posterior fossa, brainstem, cerebral hemisphere, temporal lobes, sellar/suprasellar region, pineal region and intraventricular region. Intracranial manifestations of systemic tumors like leukemia, lymphoma, neuroblastoma and some tumor-like entities like epidermoid cyst, histiocytosis X are reviewed also. The typical and unusual imaging findings of these tumors will be discussed along with their differential diagnosis.

**Summary/Conclusion**
Pediatric brain tumors are commonly encountered tumors. Most of the time they reveal typical imaging features, but sometimes they show unusual imaging appearances. Careful and systemic analysis of these imaging features is important in offering a correct diagnosis and help in patient management. MR and CT imaging both are invaluable in the depiction of these tumors.

**Key Words:** Pediatric neoplasms, imaging

**Bi-Pedicular Altanate Cement Injection Method in Percutaneous Vertebroplasty: A Novel Technique to Accomplish Optimal Cement Filling without Cement Leakage**

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**Purpose**
For the last 5 years, we performed 520 percutaneous vertebroplasty (PV) for painful compression fractures due to osteoporosis and metastasis. Although PV has become popular in many countries, various issues have been unsolved including the indication and techniques. We will present the detail PV techniques which include 1) bi-pedicular needle placement, 2) alternate cement injection from each needle and 3) pediculoplasty.

**Approach/Methods**
Percutaneous vertebroplasty is performed under local anesthesia in all patients. As a general rule, 11-gauge Osteosite biopsy needles are used. As to stylets (internal needles), diamond-cut stylets are used predominantly, and when minor directional adjustment is needed, bevel-cut stylets are used. Cement injection is performed under the guidance of biplane x-ray fluoroscopy, and blood pressure, ECG (electrocardiogram) and arterial oxygen saturation is monitored during procedure. 1) Bi-pedicular needle placement. Percutaneous vertebroplasty is performed using two needles placed through the left and right pedicles. 2) Alternative injection methods. Before injecting cement, the stylets of both needles are removed and saline is injected to evaluate communication of two needles. Then, cement injection is performed from one side while the stylet of the opposite side is withdrawn. Cement is injected till we find good filling of one side of the vertebra. If minimal cement leakage occurs outside of the vertebra during injection, the needle is pulled back for a 1 cm and we wait for a while. After completion of cement injection from the opposite side, additional cement injection is made via the opposite needle till we achieve optimal cement filling. Obturator needles frequently are used during PV to avoid cement solidification inside of the needle. 3) Pediculoplasty. When the pedicle of treating vertebra shows fracture or is involved by tumor, cement can be injected into the pedicle with a slow fractional injection method.

**Findings/Discussion**
We will underscore the efficacy of the alternate cement injection method to achieve optimal cement distribution without cement leakage outside the vertebra. We also will present preoperative evaluation of the CT and MRI to avoid cement leakage.

**Summary/Conclusion**
Bi-pedicular injection technique will lead to satisfactory PV without cement leakage outside of the treated vertebra.

**Key Words:** Vertebroplasty, technique

**Epidural Blood Patch: The How's and Why's**

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**Purpose**
The purpose of this exhibit is to illustrate and discuss CT-fluoroscopically-guided epidural blood patch treatment of intracranial hypotension. Understanding of this topic is important to radiologists who have spinal interventions as part of their practice.
**APPROACH/METHODS**
This a retrospective review of CT-fluoroscopically-guided epidural blood patch placements performed by the neuroradiology section at our institution over the course of the last 3 years. Clinical and radiologic presentations, technical considerations, and patient outcomes were reviewed.

**FINDINGS/DISCUSSION**
In this exhibit, we will discuss various clinical and radiologic presentations of intracranial hypotension, cerebrospinal fluid (CSF) flow dynamics and physiology, various types of CSF leaks, as well as present indications for fluoroscopic and CT-guided EBP placements. Intracranial hypotension is a well known clinical entity, the hallmark of which is a positional headache aggravated in the upright position and relieved while supine. While most instances relate to a specific inciting event, such as trauma, surgery, or lumbar puncture, some patients present with a compelling history in the absence of such an identifiable cause. This entity, termed spontaneous intracranial hypotension, appears to result from nontraumatic cerebrospinal fluid leaks. Although MRI and CT myelography have shown promise in the diagnosis of these problematic cases, there are many elusive cases in which it is difficult to localize the site of leakage, and the diagnosis remains predominantly a clinical one. Conservative management remains the first-line therapy for these patients, with EBP reserved for those that fail this treatment. The typical scenarios for EBP placement in our experience include suspected CSF leak following diagnostic lumbar puncture or as part of myelography procedure after failed conservative management, radiologically proved CSF leak (by CT or MR myelography), and suspected radiographically occult CSF leak based on clinical symptoms and/or secondary MR features. A variety of postulated explanations regarding mechanism of action are explored.

**SUMMARY/CONCLUSION**
Epidural blood patches as a successful treatment of intracranial hypotension secondary to CSF leak is a well documented procedure in other medical subspecialties. We explore technical considerations using imaging, clinical circumstances, and hypothesized mechanisms of action.

**KEY WORDS:** CSF leak, epidural blood patch, CT fluoroscopy

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**Electronic Scientific Exhibit 84**

Keck School of Medicine of the University of Southern California Comprehensive Spinal Imaging Course: Chapter 5, Spondylolysis, Spondylolisthesis and Related Abnormalities

Rothman, S. L. G.
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**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 2 years a comprehensive 10-hour, interactive course in diagnostic imaging of the spine has been created including plain x-ray, videoflouroscopy, CT and MR imaging. The purpose of this computer exhibit is to demonstrate the imaging characteristics of spondylolysis, spondylolisthesis and related anatomical abnormalities. Spondylolysis and all its variants represent the most common nondegenerative disorder of the lower spine. It is intended to weave a total picture of spinal anatomy, and pathophysiology of the set of disorders.

**APPROACH/METHODS**
A PowerPoint lecture on various aspects of spondylolisthesis, spondylolysis and its related disorders will be read from CDs. Imbedded in these presentations is a combination of text and voice used to challenge the trainee’s powers of observation and deduction. There are quiz questions about the images pervading the lectures.

**FINDINGS/DISCUSSION**
Chapter 5 of the University of Southern California radiology course will teach the radiographic anatomy and physiology of spondylolysis and spondylolisthesis in a most unusual way.

**SUMMARY/CONCLUSION**
The course in its entirety provides a novel approach for learning spinal imaging.

**KEY WORDS:** Spine, spondylolisthesis, spondylolysis
Electronic Scientific Exhibit 85

Withdrawn

Electronic Scientific Exhibit 86

Extraspinal Findings Detected on Dedicated Spine Imaging Studies: Prognostic Implications and Need for Further Imaging

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William Beaumont Hospital
Royal Oak, MI

PURPOSE
1) To identify, display and characterize abnormalities outside the spine, including but not limited to the abdominal and pelvic organs included on routine imaging of the spine and 2) To confidently describe certain findings as benign, in order to reduce the medical costs associated with undergoing unnecessary additional imaging studies, as well as the anxiety that such recommendations may produce in patients and referring physicians.

APPROACH/METHODS
We retrospectively reviewed MRI and CT scans of the spine in which either an extraspinal finding was described, an abnormality that was missed but not later identified on a subsequent examination, or studies in which the abnormality was not identified on spine imaging but was later detected on imaging of the chest, abdomen, and/or pelvis. When available, prior or follow-up spine and corroborative imaging studies from the patients’ folders on the PACS system were reviewed, along with more detailed exploration of their medical charts. Points of interest included whether the findings were detected, appropriately reported, and if additional imaging was recommended.

FINDINGS/DISCUSSION
A number of common findings were identified, including renal cysts (both simple and complex), renal neoplasms, adrenal masses, hepatic lesions, and pelvic masses ranging from benign fibroids to ovarian cysts and neoplasms. Aortic abnormalities such as aneurysms and dissections also were identified, including some occurring in patients presenting with back pain. Missed conditions included renal and adrenal solid masses and hydrouroteronephrosis, among others. The most commonly recommended additional imaging was for renal cysts, some of which had been stable on multiple prior spine studies. Some were even present on prior abdominal imaging, yet follow up was still suggested.

SUMMARY/CONCLUSION
Neuroradiologists read a substantial number of spine studies. Subspecialty training and experience in reading selective areas of the body have permitted better, more efficient interpretation. Such specialization, however, also has resulted in a gradual loss of experience and confidence in interpreting findings in other anatomical structures, which are not infrequently included. The neuroradiologist thus faces two problems: The first is the identification of an extraspinal finding which might be critical, and the second is appropriate characterization and recommendations. While some of these findings may warrant follow-up imaging and/or referral, many may be immediately and confidently dismissed as benign and clinically insignificant if the interpreting physician is familiar with their imaging characteristics.

KEY WORDS: Extraspinal, missed, recommendations

Electronic Scientific Exhibit 87

Spectrum of Spinal Epidural Abscess

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Birmingham, AL

PURPOSE
Spinal epidural abscess (SEA) remains an exigent problem due to lack of specific symptomatology. Often the diagnosis is delayed for significant period of time allowing progression of the disease and development of the complications. Though it is an uncommon disease its incidence is gradually increasing and at present it is about 2.8 cases per 10,000 admission in a tertiary care center (1). The infective organism gains access to the epidural space either directly or by hematogenous dissemination. In some cases no definite source could be identified. Diabetes mellitus, alcoholism, HIV infection and renal failure are one of the common predisposing factors. Staphylococcus aureus (SA) is the most common organism identified from the EA. We present eight cases with eight different predisposing conditions: empyema, TB, HIV infection, infection of the metallic construct, diabetes, renal failure, UTI and unknown.

APPROACH/METHODS
Sagittal STIR, T1, T2, postcontrast fat saturated T1 and axial T2 and pre and postcontrast T1 images were obtained.

FINDINGS/DISCUSSION
Four of the eight patients had thoracic involvement, two had cervical involvement, and one patient had both lumber and thoracic involvement. The patient with UTI presented with epidural abscess from the level of C2 down to L2. Three patients had isolated epidural abscess and rest of the patients had spondylodiskitis and paraspinal abscess as well. The epidural abscess in the patient with empyema tracked down from the contiguous infected pleura. Three of the patients had spinal cord involvement as well.

SUMMARY/CONCLUSION
Spinal epidural abscess is a relatively rare disease with various associations/predisposing factors. Early MRI is very important to diagnose, to evaluate extension of the disease, to plan the surgical options and also to identify the source of infection.

REFERENCES

KEY WORDS: Epidural abscess, predisposing factor
Notes
### Index of Program Participants

Numbers refer to session and presentation numbers, not to page numbers.

**Index Key:**
- E = Electronic Scientific Exhibit
- I = Invited Speaker
- O = Oral Paper
- P = Poster
- S = Scientific Exhibit

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