

AMERICAN SOCIETY OF NEURORADIOLOGY 2004 PROCEEDINGS

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Seattle
ASNR 2004

42ND ANNUAL MEETING

June 7 – 11, 2004

Washington State Convention & Trade Center ▲ Seattle, Washington

Dear Colleagues,

On behalf of your Executive Committee, I am pleased to welcome our members as well as the entire neuroscience community to Seattle, Washington for the Neuroradiology Education and Research (NER) Foundation Symposium and the 42nd Annual Meeting of the American Society of Neuroradiology (ASNR).

Why do we go to meetings? To learn, network and have a little fun in the process. The ASNR 42nd Annual Meeting offers you all of this in the span of a week.

Victor M. Haughton, MD, Program Chair, and his dedicated Program Committee, have planned a program that continues in the tradition of providing world-class educational programming on the newest clinical and technological developments in Neuroradiology.

The ASNR 2004 Annual Meeting will have over 20 Focus Sessions developed by the American Society of Head and Neck Radiology (ASHNR), American Society of Pediatric Neuroradiology (ASPNR), American Society of Interventional and Therapeutic Neuroradiology (ASITN) and the American Society of Spine Radiology (ASSR), covering a wide range of topics of interest for both the sub-specialist in neuroradiology as well as the general neuroradiologist. 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 Head and Neck Radiology (ASHNR), Vijay M. Rao, MD

American Society of Pediatric Neuroradiology (ASPNR), Charles R. Fitz, MD

American Society of Spine Radiology (ASSR), Gregg H. Zoarski, MD

American Society of Interventional and Therapeutic Neuroradiology (ASITN), Gary R. Duckwiler, MD

Other program highlights include the Advanced Imaging Seminars providing an in-depth look at advanced imaging techniques (perfusion, diffusion, fMRI spectroscopy, functional mapping), a Research Grant Writing Seminar, a Pediatric Interesting Case Conference, ELC Workshop and Lectures and the successful How-To Session programming will be offered and includes breakfast, lunch and reception sessions during the week.

All in all, the ASNR 42nd Annual Meeting offers programming for every type of practice, in a diversified format with something for everyone. The meeting also provides excellent opportunities to renew old friendships and make new ones at the Welcome Reception with Technical Exhibitors on Monday evening and the "Pike Place Market" Reception on Wednesday featuring the "Best of the Northwest" fine craft show, a showcase of work by local Pike Place artists.

Don't Miss the Seattle Experience

Following a day of informative educational sessions for the mind, treat your spirit to an evening of feasting on the sights and tastes of Seattle and the Puget Sound. Attendees have an opportunity to see the city and enjoy dinner and evening with family and friends through the evening dinner tours offered through the expanded Optional Tour Program.

On behalf of the entire Executive Committee, we welcome you to Seattle, Washington for the NER Foundation Symposium and ASNR 42nd Annual Meeting where advanced technology, clinical imaging and interventional neuroradiological excellence come together.



Sincerely,

Charles M. Strother, MD

President

American Society of Neuroradiology

Welcome Message

Victor M. Haughton, MD

ANSR President-Elect/Program Chair

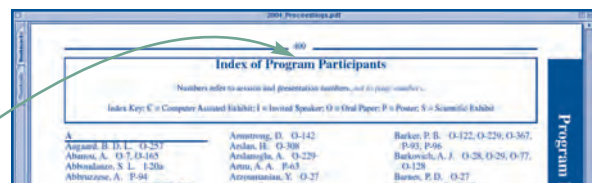
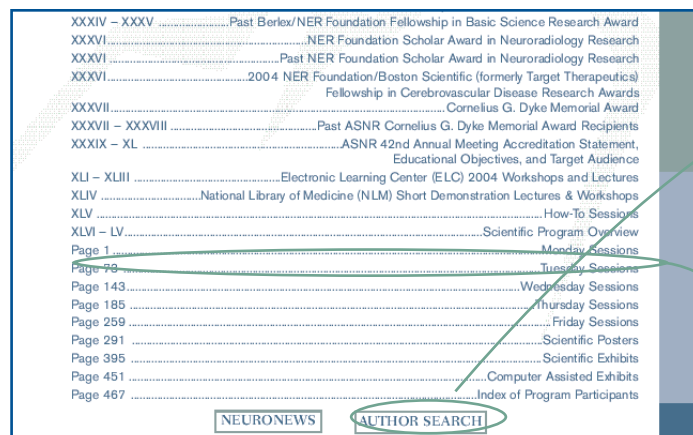
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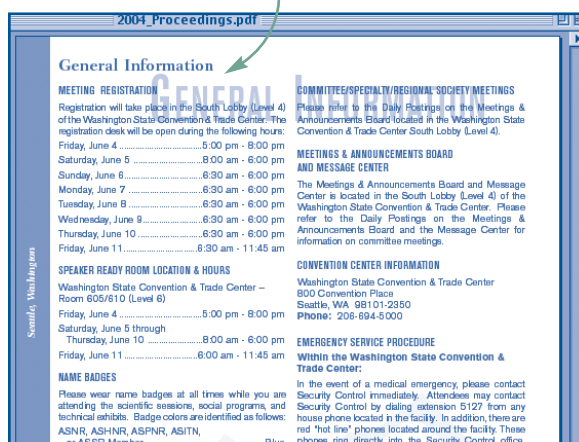
How to use your Proceedings CD-Rom

With free Acrobat Reader® software, you can view and print Adobe PDF files. If your computer doesn't already have Acrobat installed you can simply download either a Macintosh® or Windows® version from this CD-Rom. With this CD-Rom you can search the data in many different ways as shown in the examples below:

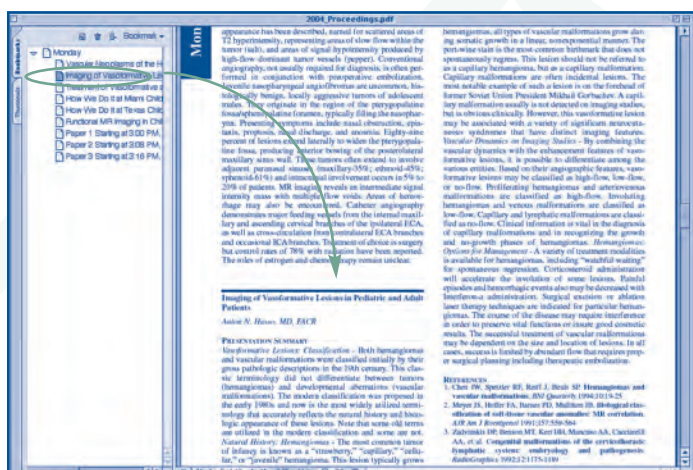


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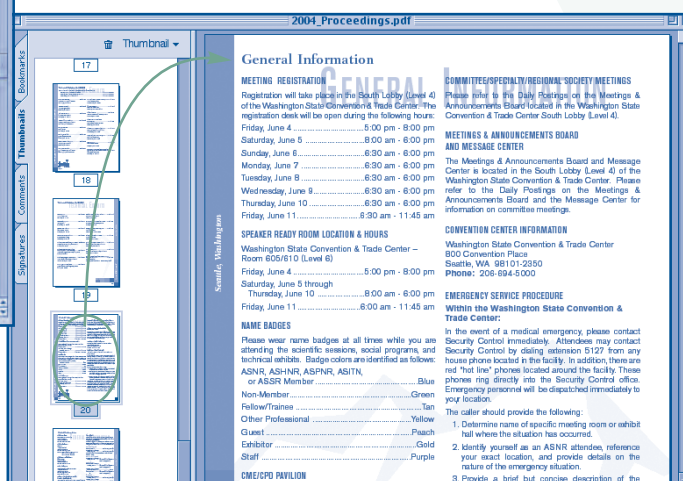
User can link from the Table of Contents to pages throughout the CD-Rom as shown above by simply clicking on the links in the file.



You can easily move to a page of your choice.



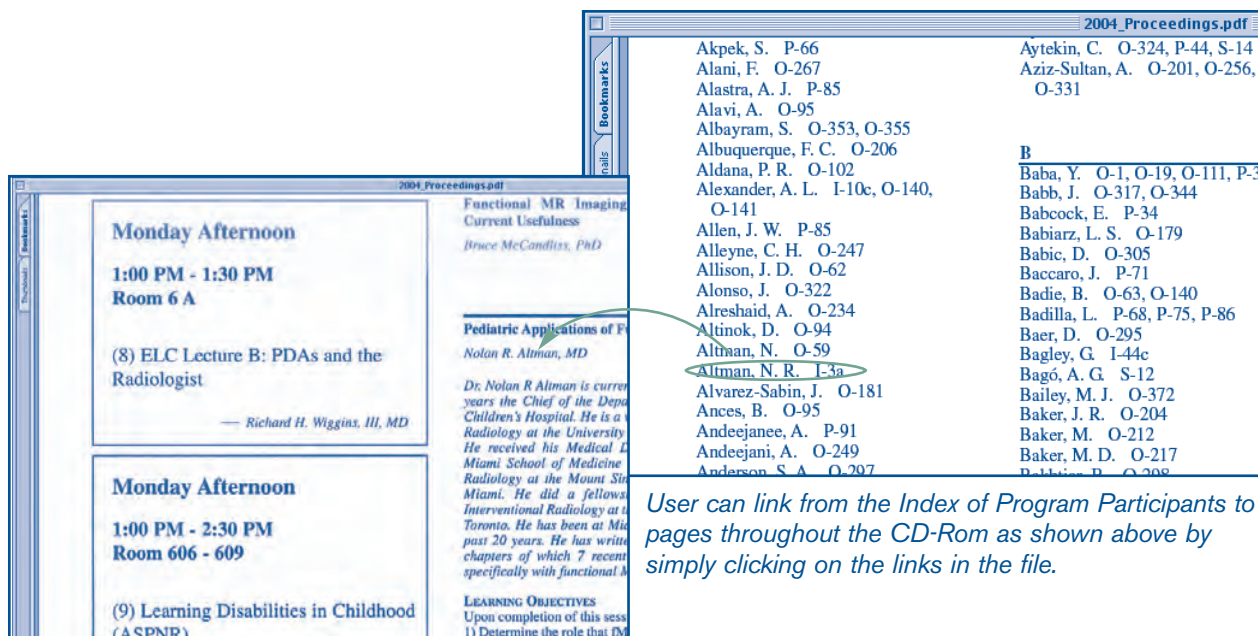
Convenient Bookmarks make it easy to jump to specific sessions throughout the week's program.



The Thumbnail palette displays a small image of each page in the proceedings for quick viewing.

How to use your Proceedings CD-Rom (continued)

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CD-Rom Basic Training

Blue Text: Indicates links – click on blue text to go directly to the page indicated.

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42nd Annual Meeting Invited Speakers

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Uniformed Services University of the Health Sciences

A. James Barkovich, MD
University of California, San Francisco

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Stanford University Medical Center

John D. Barr, MD
Mid South Imaging and Therapeutics

Clifford J. Belden, MD
Albany Medical Center

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Bay View Medical Center*

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Harborview Medical Center

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Jonathan H. Burdette, MD
Wake Forest University, Baptist Medical Center

Kim M. Cecil, PhD
Children's Hospital Medical Center, Cincinnati

Soonmee Cha, MD
University of California, San Francisco

John J. Connors, III, MD
Miami Cardiac and Vascular Institute

Thomas E. Conturo, MD, PhD
Washington University, St. Louis

Robert W. Dalley, MD
University of Washington Medical Center

H. Christian Davidson, MD
Uniformed Services University of Health Sciences

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Washington University School of Medicine

Jacques E. Dion, MD
Emory University School of Medicine

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Gary R. Duckwiler, MD
University of California, Los Angeles

Ulrike Dydak, PhD
University and ETH Zurich, Switzerland

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Toronto Western Hospital University, Canada

Massimo Filippi, MD
Scientific Institute Ospedale, San Raffaele, Italy

Nancy J. Fischbein, MD
University of California, San Francisco Medical Center

Melanie B. Fukui, MD
Allegheny General Hospital

P. Ellen Grant, MD
Massachusetts General Hospital

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New York University Medical Center

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

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Texas Children's Hospital

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Mayo Clinic

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Christiane Kuhl, PhD
University of Bonn, Germany

Timothy L. Larson, MD
Seattle Radiologists

Michael H. Lev, MD
Harvard Medical School

Robert B. Lufkin, MD
University of California, Los Angeles

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

Bruce McCandliss, PhD
Weill Medical College of Cornell University

Thomas E. Merchant, DO, PhD
St. Jude Children's Research Hospital

David J. Mikulis, MD
Toronto Western Hospital, Canada

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



42nd Annual Meeting Invited Speakers (continued)

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University of Michigan Health System

Yuichi Murayama, MD

University of California, Los Angeles Medical School

Kieran P.J. Murphy, MD

The Johns Hopkins University School of Medicine

F. Reed Murtagh, MD

University of South Florida College of Medicine

Diego B. Nunez Jr., MD, MPH

Hospital of St. Raphael, New Haven, CT

Roger Packer, MD

Children's National Medical Center, Washington, DC

James J. Pekar, PhD

Kennedy Krieger Institute

C. Douglas Phillips, MD

University of Virginia Health System

John A. Plunkett, MD

Regina Medical Center, Hastings, MN

J. Arliss Pollock, MD

Radiological Associates, Sacramento, CA

Tina Young Poussaint, MD

Children's Hospital, Boston

James M. Provenzale, MD

Duke University Medical Center

Janet S. Rasey, PhD

University of Washington

Timothy P.L. Roberts, PhD

University of Toronto, Princess Margaret Hospital, Canada

Lucy B. Rorke, MD

The Children's Hospital of Philadelphia

Howard A. Rowley, MD

University of Wisconsin Hospitals and Clinics

Kurt P. Schellhas, MD

Center for Diagnostic Imaging, St. Louis Park, MN

Jeffrey Silber, MD

*Long Island Jewish Medical Center/
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University of Iowa College of Medicine

Jeffrey A. Stone, MD

Medical College of Georgia

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Steven M. Stufflebeam, MD

Massachusetts General Hospital

Gordon K. Sze, MD

Yale University Medical Center

Lawrence N. Tanenbaum, MD

Edison Radiological Group

Thomas A. Tomsick, MD

University of Cincinnati Medical Center

J. Pablo Villablanca, MD

*David Geffen School of Medicine
at University of California, Los Angeles*

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University of Miami, Jackson Memorial Hospital

Michael W. Weiner, MD

University of California, San Francisco Medical Center

Daniel W. Williams, III, MD

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Joan C. Wojak, MD

*Our Lady of Lourdes Regional Medical Center,
Louisiana*

David M. Yousem, MD

The Johns Hopkins University School of Medicine

Robert A. Zimmerman, MD

The Children's Hospital of Philadelphia

About Seattle, Washington

The diversity of cultural and outdoor venues makes Seattle and the Puget Sound region an exciting destination for visitors. Situated on the shores of two large lakes and Puget Sound, with remote wilderness less than an hour away, Seattle is flanked by two major mountain ranges (Olympics and Cascades), providing visitors with dramatic views of Mount Rainier and a temperate climate year-round.

The opportunities for sightseeing abound with world-class attractions practically at the doorstep of the Sheraton Seattle Hotel and Towers, the headquarter hotel for the ASNR 42nd Annual Meeting. Among the most popular urban attractions are the Seattle Center and the Space Needle, Pike Place Market, Pioneer Square, and the International District.

Seattle is home to the nation's 7th largest population of artists, supported in part by an innovative public arts funding program. The arts scene includes the Seattle Art Museum, Seattle Asian Art Museum, Experience Museum Project rock and roll museum, Seattle Symphony, now in the world class Benaroya Hall, Seattle Opera and the Pacific Northwest Ballet. The symphony and ballet have performances scheduled during the annual meeting dates.

The internationally known glass artist Dale Chihuly, also makes his home in Seattle. ASNR meeting attendees who stay at the headquarter hotel, the Sheraton Seattle Hotel and Towers, will experience the beauty of glass blown art daily as the hotel houses one of the renowned Pilchuck Glass collections including pieces by Chihuly.

Walking Map of Seattle, Washington



ASNR would like to thank NORTHSTAR Travel Media, LLC for the use of their Seattle, WA downtown area map.





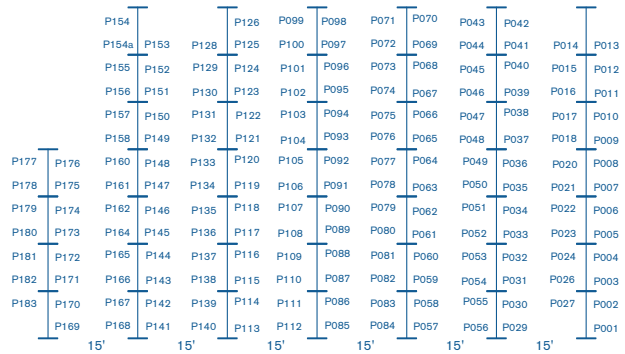
Washington State
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Level 4

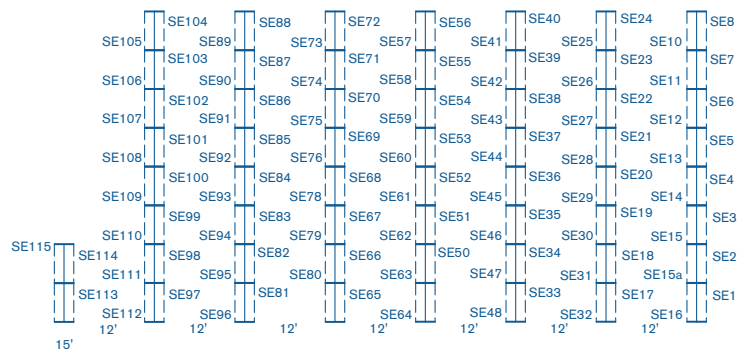
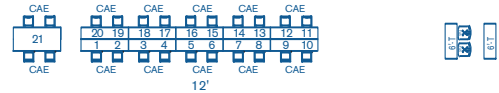
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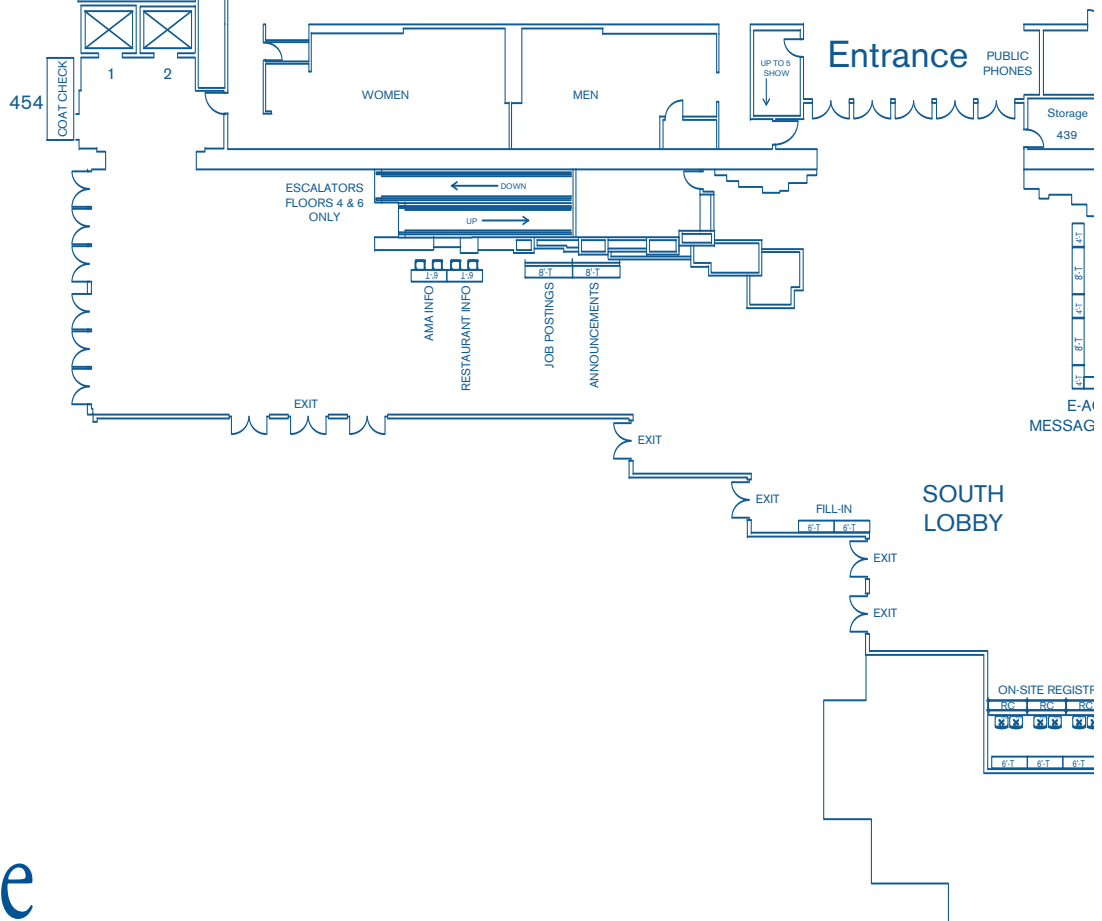
Scientific Posters



CAE Exhibits



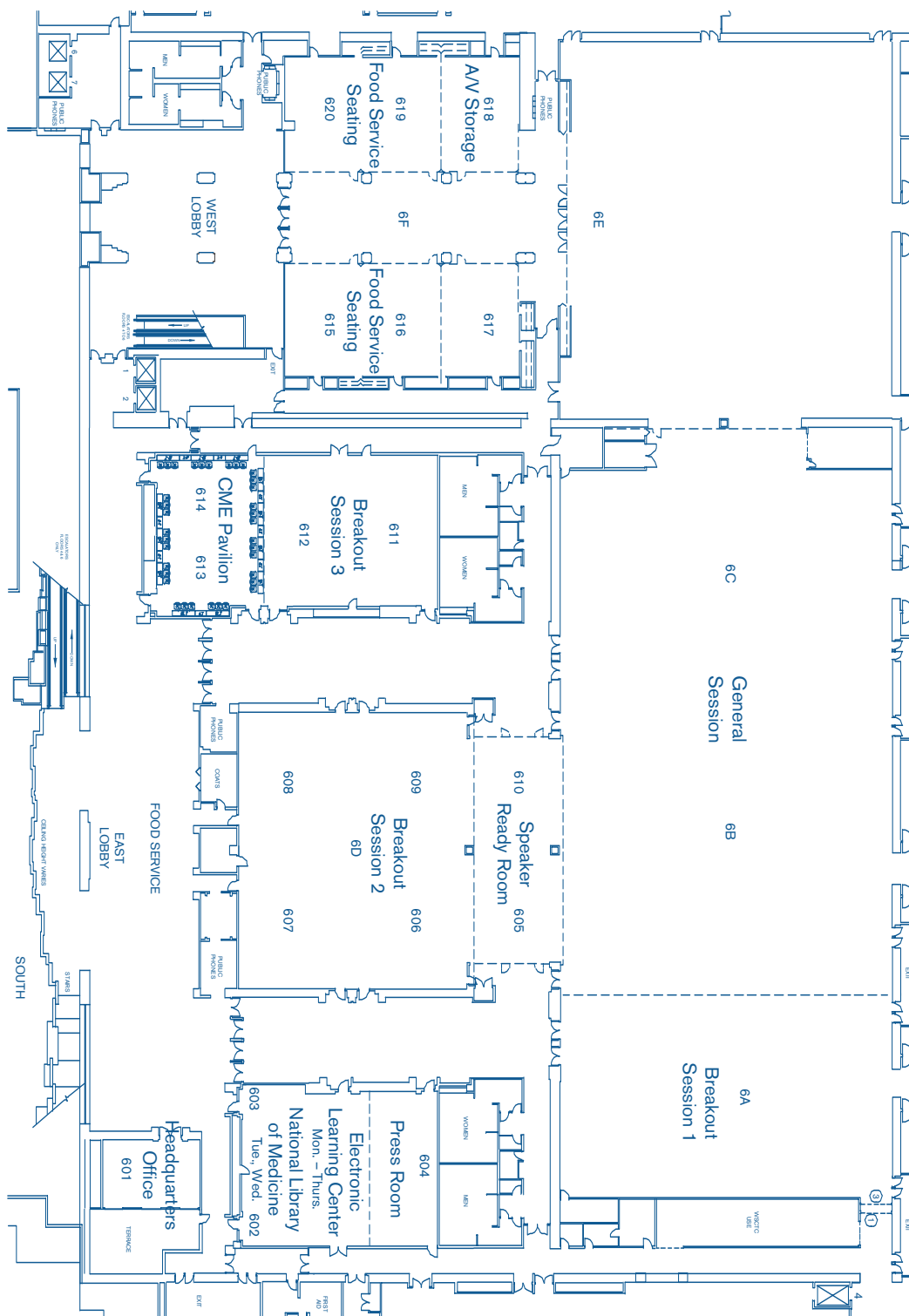
Scientific Exhibits



Seattle
ASNR 2004



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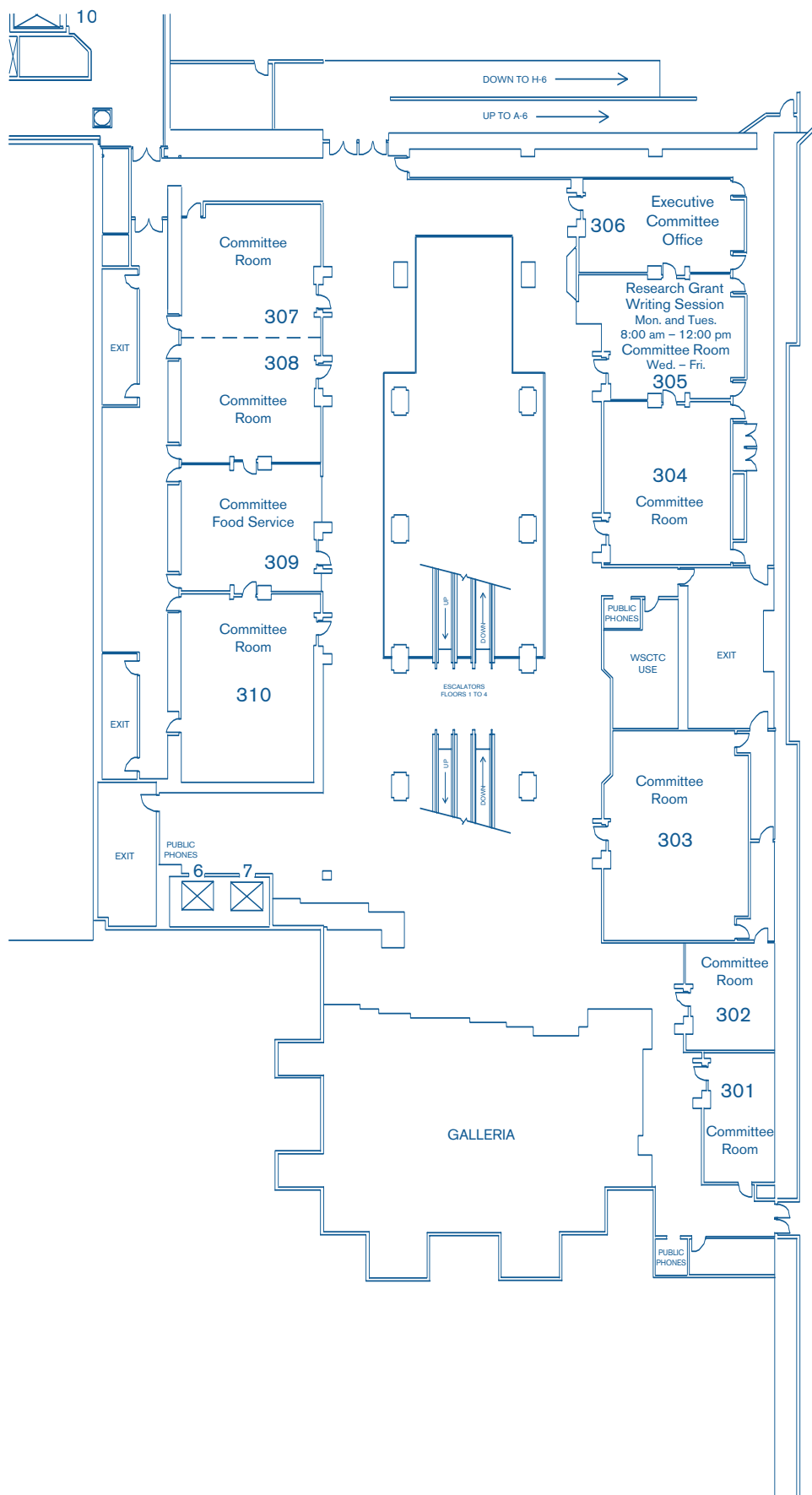
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June 7 – 11, 2004

ASNR 42nd Annual Meeting





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Convention &
Trade Center

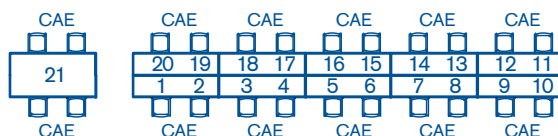
Scientific Posters, Scientific Exhibits and Computer Assisted Exhibits

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Hall 4B – Level 4

(As of 4/21/2004)

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SE108	SE91	SE75	SE59	SE43	SE37	SE27	SE4
SE109	SE101	SE85	SE60	SE53	SE36	SE28	SE3
SE110	SE92	SE76	SE68	SE52	SE35	SE29	SE2
SE111	SE100	SE84	SE62	SE51	SE34	SE30	SE1
SE112	SE93	SE78	SE67	SE50	SE33	SE31	
SE113	SE99	SE83	SE63	SE47	SE32	SE17	
SE114	SE98	SE82	SE66	SE48		SE15a	
SE115	SE95	SE80	SE64			SE16	
	SE97	SE81	SE65				
	SE96						

Seattle
ASNR 2004



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

Hall 4B – Level 4

(As of 4/21/2004)

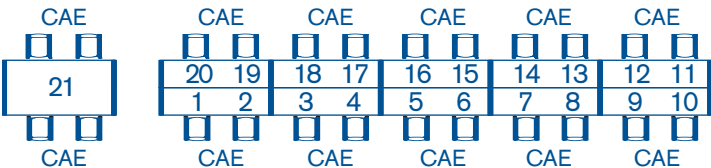
SCIENTIFIC POSTERS

Adult Brain	1-93
Head and Neck.....	94-108
Interventional.....	109-148
Pediatrics	149-168
Spine.....	169-185

		P154		P126	P099	P098	P071	P070	P043	P042			
		P154a	P153	P128	P125	P100	P097	P072	P069	P044	P041	P014	P013
		P155	P152	P129	P124	P101	P096	P073	P068	P045	P040	P015	P012
		P156	P151	P130	P123	P102	P095	P074	P067	P046	P039	P016	P011
		P157	P150	P131	P122	P103	P094	P075	P066	P047	P038	P017	P010
		P158	P149	P132	P121	P104	P093	P076	P065	P048	P037	P018	P009
P177	P176	P160	P148	P133	P120	P105	P092	P077	P064	P049	P036	P020	P008
P178	P175	P161	P147	P134	P119	P106	P091	P078	P063	P050	P035	P021	P007
P179	P174	P162	P146	P135	P118	P107	P090	P079	P062	P051	P034	P022	P006
P180	P173	P164	P145	P136	P117	P108	P089	P080	P061	P052	P033	P023	P005
P181	P172	P165	P144	P137	P116	P109	P088	P081	P060	P053	P032	P024	P004
P182	P171	P166	P143	P138	P115	P110	P087	P082	P059	P054	P031	P026	P003
P183	P170	P167	P142	P139	P114	P111	P086	P083	P058	P055	P030	P027	P002
	P169	P168	P141	P140	P113	P112	P085	P084	P057	P056	P029		P001

COMPUTER ASSISTED EXHIBITS

Adult Brain	1-15
Head and Neck	17-22
Interventional	24-31
Pediatrics	32-33
Socioeconomics	34
Spine	35-40



Unless otherwise indicated, all Computer Assisted Exhibits can be viewed from any computer station.





Washington State
Convention &
Trade Center

Scientific Exhibits

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

Hall 4B – Level 4

(As of 4/21/2004)

SCIENTIFIC EXHIBITS

Adult Brain 1-66
Head and Neck 67-84
Interventional 85-94
Pediatrics 95-107
Spine.....108-115

		SE104		SE88		SE72		SE56		SE40		SE24		SE8
SE105		SE89		SE73		SE57		SE41		SE25		SE10		SE7
		SE103		SE87		SE71		SE55		SE39		SE23		SE6
SE106		SE90		SE74		SE58		SE42		SE26		SE11		SE5
		SE102		SE86		SE70		SE54		SE38		SE22		SE4
SE107		SE91		SE75		SE59		SE43		SE27		SE12		SE3
		SE101		SE85		SE69		SE53		SE37		SE21		SE2
SE108		SE92		SE76		SE60		SE44		SE28		SE13		SE1
		SE100		SE84		SE68		SE52		SE36		SE20		
SE109		SE93		SE78		SE62		SE46		SE29		SE14		
		SE99		SE83		SE67		SE51		SE35		SE19		
SE110		SE94		SE79		SE63		SE47		SE30		SE15		
		SE98		SE82		SE66		SE50		SE34		SE18		
SE115	SE114	SE95		SE80		SE64		SE48		SE31		SE15a		
	SE111	SE96		SE81		SE65				SE33		SE17		
	SE113									SE32		SE16		
	SE112													

Technical Exhibits



Washington State
Convention &
Trade Center

Hall 4A – Level 4

(As of 4/21/2004)

FOOD SERVICE

	DISC- O-TECH 224
	NIGHT HAWK 222

ASNR 225	
WFNRS 223	KYPHON 322

CARDINAL HEALTH 325	
MRI DEVICES 323	MEDRAD 422

MICRUS CORP. 20'
116

20'	
STRYKER	20'
117	

20'	
BOSTON SCIENTIFIC	20'
217	

20'	
PHILIPS MEDICAL SYSTEMS	20'
317	

MICRO VENTION 20'
110

20'	
GE HEALTHCARE	20'
111	

FOOD SERVICE

20'	
HITACHI MEDICAL SYSTEMS	20'
311	

INTEGRA SPINAL SPECIAL. 413

NMFAP 411

MEDNOVUS 409

NLM 407

SCOTT & WHITE 106

SPRINGER -VERLAG 107	AMERSHAM HEALTH 206

4-D NEURO. 207	ELSEVIER 306

FOOD SERVICE

VIRTUAL RADIOLOGIC 104

20'	
BERLEX IMAGING	20'
101	

20'	
SIEMENS MEDICAL SOLUTIONS	20'
201	

BRACCO DIAG. 303	
COOK INCORP. 301	ARTHRO-CARE 20' 400

LIPPINCOTT, WILLIAMS, WILKINS 401

June 7 – 11, 2004

ASNR 42nd Annual Meeting



Technical Exhibits *(As of 4/21/2004)*

Washington State Convention & Trade Center – Exhibit Hall 4C

Monday, June 7 – Welcome Reception 6:00 pm – 7:30 pm
 Tuesday, June 8 through Thursday, June 10.....9:30 am – 4:00 pm
 Wednesday, June 9 – Reception 6:00 pm – 7:30 pm

4-D Neuroimaging Booth 207

9727 Pacific Heights Boulevard
 San Diego, CA 92121

Amersham Health Booth 206

101 Carnegie Center
 Princeton, NJ 08540

ArthroCare Spine Booth 400

680 Vaqueros Avenue
 Sunnyvale, CA 94085

ASNR/NER Foundation Booth 225

2210 Midwest Road, Suite 207
 Oak Brook, IL 60523-8205

Berlex Imaging Booth 101

P.O. Box 100
 Montville, NJ 07045

Boston Scientific Booth 217

47900 Bayside Parkway
 Fremont, CA 94538

Bracco Diagnostics, Inc. Booth 303

107 College Road East
 Princeton, NJ 08543

Cardinal Health.....Booth 325

1500 Waukegan Road
 McGaw Park, IL 60085

Cook Incorporated.....Booth 301

750 Daniels Way, P.O. Box 489
 Bloomington, IN 47402-0489

Disc Orthopaedic Technologies, Inc. Booth 224

7 Centre Drive, Suite 1
 Monroe Township, NJ 08831

Elsevier Booth 306

15021 75 Avenue NE
 Kenmore, WA 98028-4649

GE Healthcare Booth 111

3000 N. Grandview Boulevard, W-402
 Waukesha, WI 53188

Hitachi Medical Systems America, Inc. Booth 311

1959 Summit Commerce Park
 Twinsburg, OH 44087

Integra Spinal Specialties Booth 413

12001 Network, Building F 208
 San Antonio, TX 78249

Kyphon Inc.....Booth 322

1221 Crossman Avenue
 Sunnyvale, CA 94089

Lippincott, Williams & Wilkins Booth 401

4816 139th Place SE
 Snohomish, WA 98296

TECHNICAL EXHIBITS

**Mednovus, Inc./Quantum Magnetics, Inc.,
an Invision Technologies Company Booth 409**

664 Hymettus Avenue
Leucadia, CA 92024

Medrad, Inc. Booth 422

One Medrad Drive
Indianola, PA 15051

MicroVention, Inc. Booth 110

75 Columbia, Suite A
Aliso Viejo, CA 92656

Micrus Corporation Booth 116

610 Palomar Avenue
Sunnyvale, CA 94085

MRI Devices Corporation.....Booth 323

1515 Paramount Drive
Waukesha, WI 53186

National Library of Medicine (NLM).....Booth 407

University of Washington, Box 357155
Seattle, WA 98195

**National Medical Foundation
for Asset Protection (NMFAP) Booth 411**

2230 North University Parkway, #2-C
Provo, UT 84604

NightHawk Radiology Services Booth 222

250 Northwest Boulevard, Suite 202
Coeur d'Alene, ID 83814

Philips Medical Systems Booth 317

3000 Minuteman Road
Andover, MA 01810

Scott & White Health Systems Booth 106

2401 South 31st Street
Temple, TX 76508

Siemens Medical Solutions Booth 201

51 Valley Stream Parkway, #H-33
Malvern, PA 19355

Springer-Verlag New York, Inc. Booth 107

175 Fifth Avenue
New York, NY 10010-7858

Stryker Booth 117

4100 East Milham
Kalamazoo, MI 49001

Virtual Radiologic Consultants Booth 104

5995 Opus Parkway, Suite 200
Minneapolis (Minnetonka), MN 55343-9058

Vital Images, Inc. Booth 100

3300 Fernbrook Lane North, Suite 200
Plymouth, MN 55447

**World Federation of Neuroradiological
Societies (WFNRS) Booth 223**

Meeting Dates:

Adelaide, Australia – March 19-24, 2006



General Information

MEETING REGISTRATION

Registration will take place in the South Lobby (Level 4) of the Washington State Convention & Trade Center. The registration desk will be open during the following hours:

Friday, June 4	5:00 pm - 8:00 pm
Saturday, June 5	8:00 am - 6:00 pm
Sunday, June 6	6:30 am - 6:00 pm
Monday, June 7	6:30 am - 6:00 pm
Tuesday, June 8	6:30 am - 6:00 pm
Wednesday, June 9	6:30 am - 6:00 pm
Thursday, June 10	6:30 am - 6:00 pm
Friday, June 11	6:30 am - 11:45 am

SPEAKER READY ROOM LOCATION & HOURS

Washington State Convention & Trade Center –
Room 605/610 (Level 6)

Friday, June 4	5:00 pm - 8:00 pm
Saturday, June 5 through Thursday, June 10	8:00 am - 6:00 pm
Friday, June 11	6:00 am - 11:45 am

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, ASHNR, ASPNR, ASITN, or ASSR Member	Blue
Non-Member	Green
Fellow/Trainee	Tan
Other Professional	Yellow
Guest	Peach
Exhibitor	Gold
Staff	Purple

CME/CPD PAVILION

Washington State Convention & Trade Center –
Room 613-614 (Level 6)

Saturday, June 5	1:00 pm - 9:00 pm
Sunday, June 6 through Thursday, June 10	6:30 am - 9:00 pm
Friday, June 11	6:30 am - 1:00 pm

COMMITTEE/SPECIALTY/REGIONAL SOCIETY MEETINGS

Please refer to the Daily Postings on the Meetings & Announcements Board located in the Washington State Convention & Trade Center South Lobby (Level 4).

MEETINGS & ANNOUNCEMENTS BOARD AND MESSAGE CENTER

The Meetings & Announcements Board and Message Center is located in the South Lobby (Level 4) of the Washington State Convention & Trade Center. Please refer to the Daily Postings on the Meetings & Announcements Board and the Message Center for information on committee meetings.

CONVENTION CENTER INFORMATION

Washington State Convention & Trade Center
800 Convention Place
Seattle, WA 98101-2350
Phone: 206-694-5000

EMERGENCY SERVICE PROCEDURE

Within the Washington State Convention & Trade Center:

In the event of a medical emergency, please contact Security Control immediately. Attendees may contact Security Control by dialing extension 5127 from any house phone located in the facility. In addition, there are red "hot line" phones located around the facility. These phones ring directly into the Security Control office. Emergency personnel will be dispatched immediately to your location.

The caller should provide the following:

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

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

General Information

NEAREST HOSPITAL

Harborview Medical Center
325 9th Avenue
Seattle, WA 98101
Phone: 206-731-3000

NEAREST PHARMACY

Rite Aid
1319 Pike Street
Seattle, WA 98101
Phone: 206-223-0512
Hours: Mon. – Fri. 6:00 am - 9:00 pm
Sat. 8:00 am - 9:00 pm
Sun. 9:00 am - 6:00 pm

NEAREST 24-HOUR PHARMACY

Bartell Drugs
600 1st Ave N
Seattle, WA 98101
Phone: 206-284-1353

HOTEL INFORMATION

Sheraton Seattle Hotel and Towers
1400 Sixth Avenue
Seattle, WA 98101
Phone: 206-621-9000
Fax: 206-621-8441

SHERATON SEATTLE HOTEL AND TOWERS BUSINESS CENTER SERVICES

The Sheraton Seattle Hotel and Towers Business Center is conveniently located near the escalators on the second floor. The Business Center offers copying, faxing, and binding on a fee basis.

Hours: Mon. – Fri. 7:30 am - 5:00 pm
Sat. 10:00 am - 2:00 pm
(24-hour self-service)

PHOTOCOPY SERVICE & WSCTC BUSINESS CENTER SERVICES

Kinko's
Washington State Convention & Trade Center
735 Pike Street
Seattle, WA 98101
Phone: 206-467-1767
Fax: 206-467-1321
Hours: Mon. 7:00 am – Fri. 10:00 pm
(24 hour basis)
Sat. & Sun. 9:00 am - 9:00 pm

FOOD SERVICE

ASNR Food Service will be served in Exhibit Hall 4A during technical exhibition hours or in Ballroom 6 B/C Foyer/East Lobby (Level 6).

Continental Breakfasts, Morning and Afternoon Coffee Service and Box Lunches are provided complimentary throughout the week. Please refer to the schedule below.

Continental Breakfasts

Sunday, June 6 East Lobby (Level 6)
Monday, June 7 through
Friday, June 11 East Lobby (Level 6)

Use Room 619/620 for additional seating Sunday through Friday.

How-To Session Breakfasts

Monday, June 7 through
Friday, June 11 Ballroom 6 B/C Foyer and
East Lobby (Level 6)

Morning Breaks

Sunday, June 6 through
Monday, June 7 Ballroom 6 B/C Foyer and
East Lobby (Level 6)

Tuesday, June 8 through
Thursday, June 10 Hall 4A
Friday, June 11 Ballroom 6 B/C Foyer and
East Lobby (Level 6)

Box Lunches

Sunday, June 6 through
Monday, June 7 East Lobby (Level 6)
Tuesday, June 8 through
Thursday, June 10 Hall 4A

For Breaks and Lunches, use Room 619/620 for additional seating Saturday through Monday & Friday when Technical Exhibition is closed.

How-To Session Lunches

Tuesday, June 8 through
Thursday, June 10 Ballroom 6 B/C Foyer and
East Lobby (Level 6)

Afternoon Breaks

Saturday, June 5 through
Monday, June 7 Ballroom 6 B/C Foyer and
East Lobby (Level 6)

Tuesday, June 8 through
Thursday, June 10 Hall 4A

How-To Session with Refreshments

Thursday, June 10
(6:15 pm - 7:15 pm) Ballroom 6 B/C Foyer



General Information (continued)

MEETING LOCATION

Washington State Convention & Trade Center

NOTE: All scientific sessions and exhibits are located at the Washington State Convention & Trade Center.

Registration

South Lobby (Level 4)

CME/CPD Pavilion Terminals

Room 613-614 (Level 6)

E-Access/Messaging Center

South Lobby (Level 4)

General Session

Ballroom 6 B/C

How-To Breakfast/Lunch/Reception Sessions

Ballroom 6 B/C

Focus/Scientific Paper Sessions

Ballroom 6 B/C, Ballroom 6 A, Room 606-609 and Room 611-612

ELECTRONIC LEARNING CENTER (ELC) SESSIONS

Workshops

Room 602-603 (Level 6)

Lectures

Room 606-609 or Room 611-612 (Level 6)

NATIONAL LIBRARY OF MEDICINE (NLM) SESSIONS

Workshops

Room 602-603 (Level 6)

Lectures

Room 611-612 (Level 6)

EXHIBITS

Scientific Exhibits, Electronic Scientific Exhibit (eSE) Pilot Project, Scientific Posters, Computer Assisted Exhibits
Hall 4B (Level 4)

Technical Exhibits

Hall 4A (Level 4)

MISCELLANEOUS

Past-Presidents' and Executive Committee Office

Room 306 (Level 3)

Headquarters Office

Room 601 (Level 6)

Message Center and Meetings & Announcements Board

South Lobby (Level 4)

Press Room

Room 604 (Level 6)

Coat Check

Room 454 (Level 4)

Hours of Operation:

Saturday, June 5 8:00 am - 6:00 pm

Sunday, June 6 through

Thursday, June 10 6:30 am - 6:00 pm

Friday, June 11 6:00 am - 11:45 am

Optional Tour Desk Hours

Sheraton Seattle Hotel and Towers – Fuller’s Restaurant (Lobby Level)	
Saturday, June 5	12:00 pm – 4:00 pm
Sunday, June 6 through Thursday, June 10.....	8:00 am – 2:00 pm

Social Program

An exciting social program has been planned for registrants and their registered guests during the NER Foundation Symposium and ASNR 42nd Annual Meeting.

Welcome Reception with Technical Exhibitors

Monday, June 7.....6:00 pm – 7:30 pm

Washington State Convention & Trade Center – Exhibit Hall 4A (Level 4)

The Welcome Reception with Technical Exhibitors offers the perfect opportunity to get a preview of this year’s Technical Exhibit, the ASNR’s annual showcase for the newest products and services for the field of Neuroradiology. Enjoy complimentary hors d’oeuvres and beverages while you learn about the newest technology. Connect with old friends, make new ones and meet representatives from the companies participating in this year’s technical exhibition.

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

The Scientific Exhibition (scientific exhibits, electronic scientific exhibit pilot project, scientific posters and computer assisted exhibits) will also be available for viewing throughout the evening’s reception.

Ticket required for admission. A ticket to the Welcome Reception with Technical Exhibitors is included in the fee for registration categories that include Monday, June 7 and in the guest hospitality fee. Tickets for non-registered guests may be purchased at on-site registration if event is not sold out.

“Pike Place Market” Reception

Wednesday, June 9.....6:00 pm – 7:30 pm

Washington State Convention & Trade Center – Exhibit Hall 4A (Level 4)

America’s Emerald City, Seattle, is a magical place that can dazzle the senses. Whether admiring the glow of downtown from the shores of Lake Union or viewing Mt. Rainier from the Space Needle, Seattle is the place to enjoy many flavors.

Attendees and their guests are invited to experience an incredible evening at the ASNR re-created Pike Place Market. This evening’s pre-dinner reception will offer the delightful tastes, sounds and camaraderie of Seattle’s famous Pike Place Market, the oldest farmer’s market in the country. Smell the wonderful seafood, taste the fresh fruits and vegetables and the delicacies offered by international vendors, enjoy tastings from Washington State’s award winning wineries, or drink a cup of the rich coffee with a sweet treat.

Sample the true Seattle during the reception by browsing through the “Pacific Northwest” craft show featuring artists who sell their wares at the Pike Place Market. You won’t be able to resist taking home a treasure that represents the art that is unique to the Pacific Northwest.

Ticket required for admission. A ticket to the Pike Place Market Reception is included in the fee for registration categories that include Wednesday, June 9 and in the guest hospitality fee. Tickets for non-registered guests may be purchased at on-site registration if event is not sold out.



Guest Hospitality

GUEST HOSPITALITY

Sheraton Seattle Hotel and Towers Fuller's Restaurant (Lobby Level)

The Guest Hospitality area is offered for ASNR registered guests on a complimentary basis. Teens and younger individuals who are with registered guests, but are not themselves registered, may also visit the hospitality room. Afternoon snacks and beverages will be offered on Saturday, June 5. Continental breakfast, snacks and beverages will be available from Saturday, June 5 - Friday, June 11 based on program hours.

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

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

GUEST HOSPITALITY HOURS

Sheraton Seattle Hotel and Towers Fuller's Restaurant (Lobby Level)

Saturday, June 5 12:00 pm – 4:00 pm

Sunday, June 6 through

Thursday, June 10.....8:00 am – 2:00 pm

Friday, June 11 8:00 am – 11:30 am

SPECIAL PROGRAMS IN GUEST HOSPITALITY

A highlight of the Guest Hospitality program is a schedule of complimentary entertaining presentations on a variety of interesting topics. Guests will meet in Fuller's Restaurant five minutes before the presentations. Presentations will take place in Room 416 at the Sheraton Seattle Hotel and Towers.

Sunday, June 6 10:00 am – 11:00 am

Tuesday, June 8 10:00 am – 11:00 am

“Welcome to Seattle” Orientation

This session will highlight Seattle's many outstanding and unique attractions, activities and neighborhoods. Learn about those “out of the way” dining spots favored by locals. Discover which places offer the most spectacular views and the most fun. Find out where to get the greatest bargains when shopping for treasures to take home.

Monday, June 7 10:00 am – 11:00 am

Introduction to Seattle Glass Art

Seattle is a thriving center for artisans specializing in the ancient art of glass blowing. The Sheraton Seattle Hotel and Towers is home to an extensive collection of glass artworks including many Pilchuck and Chihuly pieces. Margery Aronson, noted Seattle art advisor and curator of the Sheraton's collection, will present a narrated slide show highlighting the many facets of this exciting medium, how Seattle developed as a center of world-class glass art and what to look for when purchasing glass art pieces. This presentation is a perfect introduction to the Seattle Glass Blowing Studio optional tour on June 8.

Wednesday, June 9 10:00 am – 11:00 am

Seattle Underground: History with Humor

Seattle Underground is known for its hilarious “below the surface” Seattle history tours. One of the their knowledgeable and comical guides will introduce you to the stories behind the official history of Seattle. Hear how the Founding Fathers' squabbling led to Seattle's complicated street system and how the solutions to the city's plumbing problems affected the town's elevation. Through tales of Seattle's frontier past, you'll learn about its villains and its heroes and the many obstacles Seattle has overcome to grow into the bustling metropolis it is today.

Future ASNR Annual Meetings

2005

43rd Annual Meeting
May 21 - 27
Metro Toronto Convention Centre
Toronto, Ontario, Canada

2006

44th Annual Meeting
April 29 – May 5
San Diego Convention Center
San Diego, California

2007

45th Annual Meeting
June 9 - 15
Hyatt Regency Chicago Hotel
Chicago, Illinois

2008

46th Annual Meeting
May 31 – June 6
Morial Convention Center
New Orleans, Louisiana

2009

47th Annual Meeting
May 16 - 22
Vancouver Convention &
Exhibition Centre
Vancouver, British Columbia, Canada

2010

48th Annual Meeting
May 15 - 21
Hynes Convention Center
Boston, Massachusetts

ASNR Past Presidents and Founders

1962-64 Juan M. Taveras, MD*
1964-65 Mannie M. Schechter, MD*
1965-66 Donald L. McRae, MD*
1966-67 Ernest H. Wood, MD*
1967-68 Harold O. Peterson, MD*
1968-69 Colin B. Holman, MD
1969-70 Giovanni Di Chiro, MD*
1970-71 D. Gordon Potts, MD
1971-72 Norman E. Chase, MD
1972-73 Fred J. Hodges, III, MD
1973-74 T. Hans Newton, MD
1974-75 Hillier L. Baker, Jr., MD
1975-76 Irvin I. Kricheff, 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, FACR
1991-92 R. Nick Bryan, MD, PhD
1992-93 David Norman, MD

1993-94 Glenn 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, FACR
2000-01 William S. Ball, Jr., MD
2001-02 William P. Dillon, MD
2002-03 Patrick A. Turski, MD

FOUNDING MEMBERS

Norman E. Chase, MD
Giovanni Di Chiro, MD*
William N. Hanafée, 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



Past ASNR Annual Meetings

Organizational Meeting

May 19, 1962
Keene's English Chophouse
New York

Second Business Meeting

October 5, 1962
Shoreham Hotel
Washington, DC

First Annual Meeting

October 7, 1963
Queen Elizabeth Hotel
Montreal

Second Annual Meeting

September 23, 1964
Waldorf Astoria
New York

Third Annual Meeting

June 11, 1965
Dennis Hotel
Atlantic City

Fourth Annual Meeting

June 15-16, 1966
Sheraton-Park Hotel
Washington, DC

Fifth Annual Meeting

May 15, 1967
Columbia University
New York

Sixth Annual Meeting

September 27-28, 1968
Jung Hotel
New Orleans

Seventh Annual Meeting

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

Eighth Annual Meeting

February 12-13, 1970
Washington Hilton
Washington

Ninth Annual Meeting

May 27-29, 1971
Fairmont Hotel
San Francisco

Tenth Annual Meeting

February 21-24, 1972
Maria-Isabel Sheraton
Mexico City

Eleventh Annual Meeting

May 26-28, 1973
Statler Hilton
Boston

Twelfth Annual Meeting

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

Thirteenth Annual Meeting

June 3-7, 1975
Bayshore Inn
Vancouver

Fourteenth Annual Meeting

May 18-22, 1976
Peachtree Plaza
Atlanta

Fifteenth Annual Meeting

March 27-31, 1977
Hamilton Princess Hotel
Bermuda

Sixteenth Annual Meeting

February 26-March 2, 1978
Hyatt Regency
New Orleans

Seventeenth Annual Meeting

May 20-24, 1979
Hotel Toronto
Toronto

Eighteenth Annual Meeting

March 16-21, 1980
Century Plaza
Los Angeles

Nineteenth Annual Meeting

May 5-9, 1981
Marriott Hotel
Chicago

Twentieth Annual Meeting

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

Twenty-First Annual Meeting

June 5-9, 1983
St. Francis Hotel
San Francisco



Past ASNR Annual Meetings (continued)

Twenty-Second Annual Meeting

June 2-7, 1984
Westin Copley Place Hotel
Boston

Twenty-Third Annual Meeting

February 18-23, 1985
Marriott Hotel
New Orleans

Twenty-Fourth Annual Meeting

January 19-23, 1986
Sheraton Harbor Island Hotel
San Diego

Twenty-Fifth Annual Meeting

(Silver Anniversary)
May 10-15, 1987
New York Hilton
New York

Twenty-Sixth Annual Meeting

May 15-20, 1988
Chicago Hilton & Towers
Chicago

Twenty-Seventh Annual Meeting

March 19-24, 1989
The Peabody Orlando
Orlando

Twenty-Eighth Annual Meeting

March 19-23, 1990
Century Plaza Hotel & Tower
Los Angeles

Twenty-Ninth Annual Meeting

June 9-14, 1991
The Washington Hilton and Towers
Washington, DC

Thirtieth Annual Meeting

May 31-June 5, 1992
Adam's Mark
St. Louis

Thirty-First Annual Meeting

May 17-20, 1993
Vancouver Trade and Convention Centre
Vancouver

Thirty-Second Annual Meeting

May 3-7, 1994
Opryland Hotel and Conference Center
Nashville

Thirty-Third Annual Meeting

May 23-27, 1995
Sheraton Chicago Hotel and Towers
Chicago

Thirty-Fourth Annual Meeting

June 23-27, 1996
Washington State Convention & Trade Center
Seattle

Thirty-Fifth Annual Meeting

May 18-22, 1997
Metro Toronto Convention Centre
Toronto

Thirty-Sixth Annual Meeting

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

Thirty-Seventh Annual Meeting

May 23-28, 1999
San Diego Convention Center
San Diego

Thirty-Eighth Annual Meeting

April 4-8, 2000
Hyatt Regency Atlanta
Atlanta

Thirty-Ninth Annual Meeting

April 23-27, 2001
Hynes Convention Center
Boston

Fortieth Annual Meeting

May 13-17, 2002
Vancouver Convention & Exhibition Centre
Vancouver

Forty-First Annual Meeting

April 28 – May 2, 2003
Marriott Wardman Park Hotel
Washington, DC



Awards and Honors

2004 ASNR Gold Medal Awards



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.



Dr. Ralph Heinz MD, FACR

Dr. Heinz was born in Cleveland, Ohio in 1929, and grew up in Charleston, West Virginia. He was an All State basketball center in high school, played at West Virginia University just before Jerry West, and played professionally for several years (not NBA). He graduated from the University of Pennsylvania in 1955, and

after practicing internal medicine and general surgery in the U.S. Public Health Services (USPHS), trained in radiology at the Philadelphia General Hospital, then moved to the Neurological Institute as one of the first National Institute of Health (NIH) sponsored special fellows with Dr. Taveras.

In 1964, Dr. Heinz introduced neuroradiology and "special procedures" to the Southeast United States when he moved to Emory University in Atlanta. At this time radiologists in the U.S. did the fluoroscopy in myelograms for the neurosurgeons but did not do any procedures, as we know them today. He performed and taught all types of general angiography, as well as neuroradiologic procedures. Realizing the inadequacy of the standard retrograde brachial angiograms for posterior fossa diagnosis of aneurysms and other pathology, Dr. Heinz began to catheterize the brachial artery for vertebral angiography, which gave much more detail. As soon as this was accepted, he began to use femoral catheterization to reach all the brachiocephalic branches to replace the standard method of the period, which was direct carotid puncture in the neck. Over the next few years, he taught many other neuroradiologists to use this method.

In 1965, he was appointed Member, NINCDS/NIH Neurological Science Research and Training Committee (1965-1969) taking Dr. Taveras' place in pushing neuroradiology ahead at the national level. Later, he

served a second term (1975-79) with the NIH. In each of these periods, he was involved with the financing and awarding of sponsored training programs in neuroradiology at major universities throughout the United States. At Emory, he was successful in obtaining one of the first NIH sponsored neuroradiologic programs in the United States (1965).

Dr. Heinz moved to Yale University in 1967. There he worked on the development of non-thrombogenic catheters to reduce clotting complications. A number of publications discussed the pathology, and the pathophysiology of Normal Pressure Hydrocephalus (NPH). Beginning in 1967, in an attempt to develop superior "painless" gas myelography, and in an attempt to salvage sub-dural injections in lumbar pneumoencephalography, Dr. Heinz developed the lateral C1-2 puncture, which was then used extensively by neuroradiologists.

In 1969, Dr. Heinz moved to University of Pittsburgh as Chairman. In Pittsburgh, a strong neuroradiologic team developed, including Drs. Drayer, Kerber, Rosenbaum, Dubois, Bank, Horton and Maravilla. At the same time, basic investigation in what was then called "electronic imaging" ensued. In 1971, the first "International Symposium of Electronic Imaging" took place at the University of Pittsburgh. These were the first efforts to use the amplifier, with its enormously increased efficiency in photo utilization, for permanent recording rather than just for fluoroscopy. This methodology is used every day in angiography, and in other aspects of modern radiology.

Moving to Duke in 1978, with Drs. Drayer and Dubois, a new neuroradiology section was formed. Work on 3D reformations of the carotid artery, and a series of investigations into the diagnosis of hippocampal sclerosis (1985), pathology, outcomes after lobectomy, and PET applications followed. In 1984, the textbook "Neuroradiology" as a part of the 5 volume series in "Clinical Neurosciences" was published. In addition, Dr. Heinz has published 133 scientific papers, and 32 book chapters.

None of these accomplishments could have happened without the support of family, wife, Ann, and children, Tad, Christopher, Dana, and Lindsey. Dr. Heinz continues to work and teach at Duke.

Awards and Honors

2004 ASNR Gold Medal Awards (continued)



Stephen A. Kieffer, MD, FACR

Stephen Kieffer was born in Minneapolis in 1935, and educated in the public schools of St. Paul. Following undergraduate and medical studies at the University of Minnesota and a rotating internship at the VA Center in West Los Angeles (1959-60), he returned to Minneapolis to

enter residency training in radiology. His residency was interrupted in 1962 by the Berlin wall crisis, and he served as chief of radiology at U.S. Army hospitals in Fort Polk, Louisiana, and Fort Harrison, Indiana.

Resuming his residency at the University of Minnesota in 1964, Steve worked closely with Kurt Amplatz learning the technique of percutaneous transfemoral "four vessel" angiography. A rotation with Harold O. Peterson, pioneer neuroradiologist and chair of the department, sealed his interest in neuroradiology. In January 1966, he became the second NIH sponsored fellow in neuroradiology at Minnesota, and was named a James Picker Foundation Scholar in Radiological Research. His research into the aging of the intervertebral disk as visualized on postmortem diskography with gross and microscopic anatomic correlation was presented to the American Society of Neuroradiology in 1967; he was elected to membership in the Society at that meeting.

In 1967, Dr. Kieffer joined the faculty of the Department of Radiology at Minnesota, and in 1968, he assumed the directorship of radiology at the Minneapolis VA Hospital. For the next six years, he continued to teach and do research at both the VA and the University Hospitals. Working with his chair and mentor Harold Peterson, Steve explored the applications of large volume Pantopaque Myelography in the evaluation of congenital abnormalities of the spine, degenerative disk disease and intrathecal metastases. His study of the normal scintiscisternogram using radioactive labeled albumin was selected as the outstanding paper at the 1970 ASNR meeting. A textbook by Drs. Peterson and Kieffer, "Introduction to Neuroradiology", was published in 1972 and was well received.

During the late sixties and well into the seventies, the ASNR was a relatively small and closely-knit alliance of enthusiastic clinical researchers and teachers who rapidly expanded the body of neuroradiological knowledge and applications. In 1971, at the request of ASNR President Norman Chase, Steve headed a committee that created the Cornelius G. Dyke Memorial Award, annually recognizing the outstanding original research paper presented by a young neuroradiologist.

In 1974, he left Minnesota to become Chair of Radiology at the State University of New York Upstate Medical University in Syracuse, a position he held through 1998. Working with a remarkable faculty, including Drs. E. Robert Heitzman and John G. McAfee, he encouraged the department's clinical, educational and research productivity. A neuroradiology fellowship program was established with the aid of Eugene Binet. When water-soluble agents were developed for myelography, the Syracuse group participated in their early clinical evaluation. Application of computed tomography without and with intrathecal contrast to the diagnosis of diseases of the spine and spinal cord became a major clinical research thrust. "An Atlas of Cross-Sectional Anatomy", compiled by the State University of New York, Syracuse radiologists and coedited by Drs. Kieffer and Heitzman, was published in 1979.

As President of the ASNR in 1978-79, Steve's major effort was to move forward on a proposal by Samuel Wolpert that the Society consider establishing its own journal. At the 1979 Annual Meeting, the members approved the recommendation of a committee headed by Norman Leeds that the ASNR had the size and maturity necessary to pursue this challenge. The American Journal of Neuroradiology began publication in January 1980, with Juan Taveras as Editor. In the ensuing 24 years, under the leadership of Drs. Taveras, Michael Huckman and Robert Quencer, the AJNR has greatly advanced the field of Neuroradiology.

Dr. Kieffer was a founding member of the Eastern Neuroradiological Society and served as its President in 1991-92. The ENRS has established an annual award in his name for the best paper by a neuroradiology fellow. He also served as President of the New York State Radiological Society (1987-88) and as ASNR Councilor to the American College of Radiology (1986-92). He currently co-chairs the College's Guidelines and Standards Committee for Neuroradiology and MR. He headed the ASNR's Clinical Outcomes Research Subcommittee in the mid 90's, and remains active in the ASNR's Evidence Based Medicine and Guidelines and Standards Subcommittees.

When Sadek Hilal was selected as President of the 16th Symposium Neuroradiologicum, he invited Steve to serve as Vice President. When Dr. Hilal became seriously ill in 1994, Steve assumed responsibility for organizing the Symposium, ably supported by Michael Huckman and R. Nick Bryan, and by the ASNR staff and Executive Committee. Over 1,600 neuroradiologists attended the Symposium in May 1998 in Philadelphia, in tandem with the ASNR's Annual Meeting.



Awards and Honors

2004 ASNR Gold Medal Awards (continued)

Stepping down from the Radiology Chair at State University of New York Upstate Medical University after 24 years, Steve undertook a very rewarding minisabbatical in neuroradiology with Robert Grossman, David Yousem and Laurie Loevner at the University of Pennsylvania to update his diagnostic skills. He then returned to the full time clinical practice and teaching of neuroradiology, first in Syracuse with Jack Chang and, since early in 2001, with Charles Truwit at the University of Minnesota, where he is presently Professor of Radiology and Director of the Neuroradiology Fellowship Program. He greatly enjoys being challenged by both the inquiring minds of his students and the increasing wonders of his field.

To date, Dr. Kieffer has participated in more than ninety original scientific publications, twenty-three chapters in textbooks, and two books. He has presented numerous lectureships and participated in many national and international refresher and postgraduate courses.

Steve and his wife Cyrile have been married forty-five years and have four children, Alisa, Mitchell, Stuart and Paula. They enjoy biking on the trails of their beautiful city and are happy to be living close to Mitchell, his wife, Valeria and their granddaughters, Sophia and Luiza.

Past ASNR Gold Medal Award Recipients

1995

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

1996

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

1997

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

1998

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

1999

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

2000

Hillier L. "Bud" Baker, Jr., MD

2001

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

2002

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

2003

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

**deceased*

Awards and Honors

2004 ASNR Honorary Member



Dennis Le Bihan, MD, PhD

Dr. Le Bihan, a neuroradiologist and a physicist, graduated from the University of Paris. At the completion of his training he spent seven years at NIH in Bethesda, Maryland. He also spent several years at Georgetown University, Washington D.C., as a clinical professor in neuroradiology. He is currently the Director of the Research Institute on Functional and Anatomical Neuroimaging in Orsay, France, and a member of the French Academy of Sciences. Dr. Le Bihan has made outstanding contributions to the development and clinical applications of new MRI methods allowing to image human brain function. In particular, he has been internationally well-recognized and frequently emulated

for his pioneering work on diffusion MRI which is today used worldwide both for research and clinical applications. Diffusion MRI has become an exquisite approach to study normal and diseased brain anatomy and function, especially in acute brain ischemia, and white matter and connectivity disorders.

Dr. Le Bihan has also significantly contributed to the field of functional MRI, both methodologically and clinically. For his contributions, Dr. Le Bihan was awarded the Gold Medal of the International Society for Magnetic Resonance in Medicine in 2001, the prestigious Lounsbery Award from the National (U.S.) and French Academies of Sciences in 2002 and the Louis D. Foundation Award from the Institut de France in 2003. Dr. Le Bihan has authored or co-authored more than 200 publications. He is very much in demand as a speaker at international conferences and has served on the Board of many prestigious institutions, radiological societies and journals.

Past ASNR Honorary Member Recipients

Torsten Almen, MD
James W. Bull, MD
Graeme M. Bydder, MD, ChB
M. Paul Capp, MD
Sten Cronqvist, MD
B. G. Ziedses des Plantes, MD
George du Boulay, MD
Richard R. Ernst, MD
Torgny V. B. Greitz, MD
Godfrey N. Hounsfield, PhD
Yun Peng Huang, MD
Ian Isherwood, MD
Pierre Lasjaunias, MD, PhD
Marco Leonardi, MD
Erik Lindgren
Claude H. Manelfe, MD
Joseph Ransohoff, MD*

Jesus Rodriguez-Carbajal, MD
Lee F. Rogers, MD
Prof. Lucy Balian Rorke
Michael Radford Sage, MD, FRANZCR, FRCR, FRCPC (Lon), FRCPC (Ed), FHKCR (Hon)
George Schuyler
S. I. Seldinger, MD
Fjodor Serbinenko, MD
Mutsumasa Takahashi, MD
Michel Ter Pogossian, MD
Galdino E. Valvassori, MD
Marjo S. van der Knaap, MD
Prof. Jacqueline Vignaud
M. Gazi Yasargil, MD
Ian R. Young, BSc, PhD
Paul C. Lauterbur, PhD

*deceased



Awards and Honors

ASNR 2003 Outstanding Presentation Awards

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

General Neuroradiology

"Superiority of PROPELLER FSE over Conventional FSE for Eight-Channel Phased-Array Brain Imaging in Clinical Practice"

L. N. Tanenbaum¹, J. Pipe², A. Gaddapati³,
M. Hartley³, J. Debbins³, N. Eshkar¹

¹New Jersey Neuroscience Institute – EIA, Edison, NJ;

²Barrow Neurological Institute, Phoenix, AZ;

³GE Medical Systems, Waukesha, WI

Berlex Best Paper Award in General Neuroradiology

"Initial Experience with Diffusion and Perfusion MR Imaging in Patients Undergoing Intraarterial Thrombolysis"

P. W. Schaefer, L. Roccatagliata, C. J. Ledezma,
L. Schwamm, R. G. Gonzalez

Massachusetts General Hospital, Boston, MA

Head and Neck Radiology

"Positional Vertebrobasilar Ischemia: Pathogenesis and Diagnosis"

D. W. Morton¹, W. A. Cohen², D. W. Newell²,
R. Goodkin³, M. Vilela¹, C. Douville²

¹University of Washington Medical Center, Seattle, WA;

²Harborview Medical Center, Seattle, WA; ³Seattle Veteran's Administration Puget Sound Health Care System, Seattle, WA

Interventional Neuroradiology

(The Michael Brothers Memorial Award)

"Concentric MERCI Retriever for the Treatment of Neurovascular Thrombotic Occlusions: A Phase I Nonrandomized Trial"

G. R. Duckwiler, MERCI Phase I Trial Participants

University of California Los Angeles School of Medicine, Los Angeles, CA

Pediatric Neuroradiology

(The Derek C. Harwood-Nash Award)

"Changes in Ethical Issues Based on Evolving Experience of In Utero MR Imaging for Fetal CNS Abnormalities"

P. D. Griffiths, E. H. Whitby, I. D. Wilkinson,
M. N. J. Paley

University of Sheffield, Sheffield, United Kingdom

Spine Radiology

"Thoracic Intervertebral Disks: In Vivo Characterization of Intradiskal Pressure in Healthy Volunteers During Various Maneuvers"

K. P. Schellhas¹, D. J. Polga², K. B. Wood²,
G. R. Buttermann³, B. P. Beaubien⁴, P. M. Kallemeier²

¹Center for Diagnostic Imaging, St. Louis Park, MN;

²University of Minnesota, Minneapolis, MN; ³Midwest Spine Institute, Stillwater, MN; ⁴Midwest Orthopaedic Research Foundation and Minneapolis Medical Research Foundation, Minneapolis, MN

Awards and Honors

2003 Regional Society Awards

The American Society of Neuroradiology is pleased to announce the recipients of the 2003 Regional Society Awards. These individuals were selected by the respective regional societies as having the best presentation at each society's 2003 Annual Meeting.

Eastern Neuroradiological Society (ENRS)

(The Norman E. Leeds Award)

"Molecular Imaging and Neuroradiology"

Dawid Schellingerhout, MBChB
Massachusetts General Hospital,
Boston, Massachusetts

Southeastern Neuroradiological Society (SENRS)

"Diffusion Tensor Imaging Analysis of Tract Involvement of Diffuse Brainstem Gliomas in Children with Neurological Correlation"

K. J. Helton, N. Phillips, R. B. Khan, F. A. Boop,
R.A. Sanford, P. Zou, J. Langston, R. Ogg
St. Jude Children's Research Hospital,
Memphis, Tennessee

Western Neuroradiological Society (WNRS)

(The Gabriel H. Wilson Award)

"Assessment of the Reproducibility of Post-Processing Dynamic Computed Tomography Perfusion (CTP) Data: Impact of the Optimization of Post-Enhancement Image Selection"

David J. Fiorella, MD, PhD
Barrow Neurological Institute, Phoenix, Arizona

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



This newly created award, 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.

The recipient of the award is:

Robert I. Grossman, MD
New York University Medical Center,
New York, New York



Robert I. Grossman, MD

Robert I. Grossman is recognized worldwide for his contributions to radiology research. He has lectured extensively and is the recipient of many awards and honors. In 1999, he received the Javits Neuroscience Investigator Award for his work on multiple sclerosis, one of only ten scientists in the country to receive the award.

A charter member and Chairman of the Diagnostic Radiology Study Section at National Institutes of Health (NIH), Dr. Grossman has recently been appointed to serve as a member of the National Advisory Council for Biomedical Imaging and Bioengineering which provides recommendations on the conduct and support of biomedical imaging, bioengineering research and research training.

He is the author of over 300 publications and coauthor of four books including the respected textbook, *Neuroradiology: The Requisites*. He currently serves as a Senior Editor of the *American Journal of Neuroradiology*, associate editor of *Magnetic Resonance in Medicine* and *Yearbook of Ophthalmology*, and is on the editorial boards of several scientific journals.

He has held many leadership roles at the ASNR, was recently elected Vice President, and will assume the presidency in May, 2006.



Awards and Honors

2004-2005 Berlex/NER Foundation Fellowship in Basic Science Research Award (Formerly known as the Berlex/ASNR Fellowship in Basic Science Research Award)

This fellowship, first awarded in 1986, was created by the ASNR with the support of Berlex Laboratories 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 Berlex Laboratories, Inc. and the Neuroradiology Education and Research (NER) Foundation of the American Society of Neuroradiology.

The recipients of the 2004-05 fellowships are:

Tuong Huu Le, MD, PhD
University of California, San Francisco

"Structural and Functional Correlates of Axonal Shearing in Traumatic Brain Injury: A Combined DTI, fMRI and MSI Study"

Whitney B. Pope, MD, PhD
David Geffen School of Medicine at University of California, Los Angeles

"Identification of Unstable Atherosclerotic Plaque at the Carotid Bifurcation Using High-Resolution CT-PET Imaging: Correlation to Histopathology and Patient Symptoms"

Past Berlex/NER Foundation Fellowship in Basic Science Research Award

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"

Awards and Honors

Past Berlex/NER Foundation Fellowship in Basic Science Research Award (Continued)

1993-94

Thomas E. Conturo, MD, PhD,
The Johns Hopkins Hospital and
Johns Hopkins University

"Mechanisms of the Phase Enhancement Effects of Bolus-Injected Paramagnetic Contrast Agents and Applications in Quantitative Cerebral Blood Volume and Flow Imaging"

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

1994-95

Jerry Burke, MD, Bowman Gray School of Medicine
"Serial Positron Emission Tomography and Functional MR Imaging of Stroke"

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

1995-96

Norman J. Beauchamp, MD,
The Johns Hopkins Hospital
"The Natural History of 'Areas of Risk of Infarction' as Defined by Perfusion MRI and MR Spectroscopy"

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

1996-97

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

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

1997-98

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

1998-99

William F. Marx, MD, University of Virginia
"Endovascular Treatment of Experimental Aneurysms Using Biologically Modified Embolic Coils: Promotion of Permanent Occlusion via Intra-aneurysmal Fibroblast Delivery"

1999-00

Kevin R. Moore, MD,
University of Utah Center for Advanced Medical Technology

"Meg-Constrained High-Resolution Surface-Coil MR Imaging and MR Spectroscopy for Evaluating Medically Refractory Epilepsy"

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

2000-01

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

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

2001-02

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

2002-03

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

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

2003-04

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

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



Awards and Honors

Neuroradiology and Education Research (NER) Foundation Scholar Award in Neuroradiology Research* (* Formerly known as the ASNR Foundation Award in Neuroradiology Research)

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

The recipient of the 2004 scholar award is:

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

"Diffusion Tensor MR Imaging and Quantitative Tractography of Brain Development in Premature Newborns"

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
"Alteration of Intracranial Aneurysm Flow Dynamics: Development and Evaluation of Potential Neurointerventional Endovascular Treatment Regimens of Wide Necked Aneurysms"

2004 NER Foundation/Boston Scientific (formerly Target Therapeutics, Inc.) 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 2004 fellowship is:

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"

Awards and Honors

2004 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.



Eric D. Schwartz, MD

Dr. Eric D. Schwartz graduated from Dartmouth College in 1991 with a Bachelor of Arts degree in History. He graduated from Johns Hopkins School of Medicine in 1995 and went on to a Diagnostic Radiology residency at the University of Miami, where he was chief resident and received the RSNA Roentgen Resident Research Award. He completed his Neuroradiology fellowship in 2001 at the University of Pennsylvania where he has continued and is currently an Assistant Professor.

He was granted the 2000-2001 ASNR/Berlex Basic Science Fellowship for the study of high-resolution diffusion imaging of experimental spinal cord injury, and he currently has an NIH K-award in the same subject.

The recipient of the 2004 Cornelius G. Dyke award is:

Eric D. Schwartz, MD
Hospital of the University of Pennsylvania,
Philadelphia, PA

"Apparent Diffusion Coefficients Within Spinal Cord Transplants and Surrounding White Matter Correlate With Degree of Axonal Dieback Following Injury"

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"



Awards and Honors

Past ASNR Cornelius G. Dyke Memorial Award Recipients (continued)

1983

No Award

1984

Val M. Runge, MD

"Contrast Enhanced Magnetic Resonance Evaluation of a Brain Abscess Model"

1985

No Award

1986

Jeremy B. Rubin, MD

"Part 1 Imaging Spinal CSF Pulsation by 2DFT Magnetic Resonance: Significance During Clinical Imaging"

"Part 2 Harmonic Modulation of Proton MR Precessional Phase by Pulsatile Motion Origin of Spinal CSF Flow Phenomenon"

1987

No Award

1988

Vincent P. Mathews, MD

"Gadolinium Enhanced MR Imaging of Experimental Bacterial Meningitis: Evaluation and Comparison of CT"

1989

Allen D. Elster, MD

"Europium-DTPA: Development and Testing of a Gadolinium Analogue Traceable by Fluorescence Microscopy"

1990

Marvin D. Nelson, Jr, MD

"The Search for Human Telencephalic Ventriculofungal Arteries"

1991

Udo P. Schmiedl, MD

"Quantitation of Pathological Blood-Brain Barrier Permeability in an Astrocytic Glioma using Contrast Enhanced MR"

1992

R. Gilberto Gonzalez, MD

"Quantitative In Vivo Human Brain Lithium Magnetic Resonance Spectroscopy"

Frank J. Lexa, VII, MD

"Wallerian Degeneration in the Feline Visual System: Characterization by Magnetization Transfer Rate with Histopathologic Correlation"

1993

Marc Jouandet, MD

"Mapping the Human Cerebral Cortex with Brainprints"

1994

A. Gregory Sorensen, MD

"Functional Magnetic Resonance Imaging of Brain Activity and Perfusion in Patients with Chronic Cortical Stroke A"

1995

John L. Ulmer, MD

"Magnetization Transfer or Spin-Lock? An Investigation of Off-Resonance Saturation Pulse Imaging Using Varying Frequency Offsets"

1996

John C. Strainer, MD

"fMRI of Primary Auditory Cortex: An Analysis of Pure Tone Activation and Tone Discrimination"

1997

Stephen G. Imbesi, MD

"Why Do Ulcerated Atherosclerotic Caroid Artery Plaques Embolize? A Flow Dynamics Study"

David F. Kallmes, MD

"Guglielmi Detachable Coil Embolization for Unruptured Aneurysms in Neurosurgical Candidates: A Cost Effectiveness Exploration"

1998

No Award

1999

Aquilla S. Turk, DO

"Definition of Aneurysm Ostium (Neck) and Morphology Using Intravascular Ultrasound: An Experimental Study in Canines"

2000

William F. Marx, MD

"Endovascular Treatment of Experimental Aneurysms Using Biologically Modified Embolic Devices: Coil-Mediated Intra-Aneurysmal Delivery of Fibroblast Tissue Allografts"

2001

No Award

2002

Mehmet Kocak, MD

"Functional MR Imaging of the Motor Homunculus: Towards Optimizing Paradigms for Clinical Scenarios"

2003

No Award

Continuing Medical Education (CME)/ Continuing Professional Development (CPD)

SCIENTIFIC PROGRAM AND MEETING EVALUATION

The 2004 Continuing Medical Education (CME)/Continuing Professional Development (CPD) Pavilion allows online recording of CME/CPD credits via the Internet. The improvements have created a faster and more user-friendly system for evaluating sessions and speakers and recording CME/CPD hours electronically. The CME/CPD Pavilion is easily accessible in Room 613-614 (Level 6). Please complete the evaluations for each session to assist in planning future meetings and to help us maintain accreditation of this and future programs.

CME/CPD PAVILION

To access the CME evaluation program, run the "ExpoCard" included in your registration packet 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/CPD credit hours claimed for 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 estimated number of CME/CPD credit hours earned throughout the program. It will also be possible to printout a copy of your certificate and transcript to take home with you.

Please Note: To receive CME/CPD credit for sessions attended at the NER Foundation Symposium and ASNR 42nd Annual Meeting, all evaluations must

be entered by the end of the meeting. The CME/CPD Pavilion replaces the CME/CPD booklet of previous years and is the only method available for receiving your CME credit.

NEW THIS YEAR - TAKE YOUR OFFICIAL CONTINUING MEDICAL EDUCATION (CME/CPD) CERTIFICATE HOME WITH YOU!

An enhancement of the Continuing Medical Education online evaluation system now allows for attendees to print out their official CME/CPD certificate for the number of hours claimed during the NER Foundation Symposium and ASNR 42nd Annual Meeting and take it with them when they leave. Go to any terminal in the CME/CPD Pavilion and follow the simple directions for printing out an official NER Foundation Symposium and ASNR 42nd Annual Meeting CME/CPD Certificate.

Following the meeting, the ASNR 2004 CME/CPD Certificate site will be available online for 90 days for attendees to print out their CME/CPD certificates.

Please Note: Due to the availability of CME/CPD Certificates online, no certificates will be mailed to attendees this year.

LETTER OF ATTENDANCE

If you wish to obtain a Letter of Attendance, please request one at the Registration Desk located in the South Lobby (Level 4) of the Washington State Convention & Trade Center.

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 this CME/CPD activity.

The American Society of Neuroradiology designates this educational activity for a maximum of 33.25 Category 1 credits towards the AMA Physician's Recognition Award. Each physician should claim only those credits that he or she actually spent in the activity.

Target Audience

The ASNR 42nd Annual Meeting is designed specifically for the practicing general neuroradiologist who wishes to integrate advanced imaging such as magnetic resonance spectroscopy, diffusion and perfusion imaging, and functional magnetic resonance imaging into his/her daily practice. Programming is also focused toward the neuroradiologist 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 42nd Annual Meeting Educational Objectives

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

- ▲ *Assess the current status of neuroradiological imaging of the head, neck and spine and interventional imaging in both adult and pediatric populations.*
- ▲ *Apply state of the art techniques in diffusion imaging, perfusion imaging, MRS, fMRI, and DTI in the treatment of both adult and pediatric populations.*
- ▲ *Utilize MRS as one treatment strategy for cerebral tumors in the pediatric patient.*
- ▲ *Determine management strategy options and increase skills in imaging the patient with a treated cerebral neoplasm.*
- ▲ *Discuss current imaging methodologies for head and neck carcinoma in the adult patient.*
- ▲ *Apply CT, MRI and PET imaging in the management of the previously treated head and neck patient.*
- ▲ *Identify spinal disorders and degenerative disease in the pediatric population.*
- ▲ *Utilize MDCT in the evaluation of congenital and neoplastic conditions of the sinonasal cavity.*
- ▲ *Apply current diagnostic criteria and identify imaging strategies for the treatment of neck masses in the pediatric population.*
- ▲ *Apply state of the art imaging techniques in the assessment of patients with sensorineural hearing loss.*
- ▲ *Identify and implement state of the art imaging techniques in the treatment of skull base neoplasms in adults.*
- ▲ *Demonstrate the basic knowledge of the use of the computer in the practice of Neuroradiology with reference to hardware, operating system and peripherals for both the Macintosh and PC platforms.*
- ▲ *Assess developmental lesions of the head and neck and determine appropriate imaging strategies.*
- ▲ *Evaluate the use of higher field strength and new functional imaging techniques in the diagnosis of spinal problems in the adult population.*
- ▲ *Compare current treatment modalities in spinal vascular imaging.*
- ▲ *Discuss recent advances in multidetector CT imaging of the spine.*
- ▲ *Evaluate interventional procedures for use in management of the disorders and diseases in the adult spine.*
- ▲ *Assess the role of dynamic and upright MR imaging as an option for diagnosis and treatment of the adult spine.*
- ▲ *Assess state of the art imaging procedures utilized in the treatment of atherosclerosis.*
- ▲ *Assess the clinical role of functional mapping utilizing fMRI and MEG imaging.*
- ▲ *Evaluate new imaging techniques and procedure options for the diagnosis and management of stroke and cerebral aneurysm in the adult population.*

Electronic Learning Center 2004 Workshops & Lectures

Gregory L. Katzman, MD, *Chair, Program*

Hervey D. Segall, MD, *Chair Emeritus*

Richard M. Berger, MD, *Co-Chair, Moderators*

Richard H. Wiggins, III, MD, *Co-Chair, Technical & Syllabus Editor*



ELC Workshops

Electronic Learning Center (ELC) workshops provide the opportunity for participants 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. Attendance is limited to 40 participants.

NOTE: 2 participants per computer

The 2004 ELC workshops and lectures will update attendees on the use of electronic methods useful for the practicing neuroradiologist and neuroradiologist-educator. This year's program will build on the sessions offered at the 2003 meeting.

Workshop registrants will receive a copy of the ELC 2004 Syllabus, an invaluable CD-ROM designed to complement the ELC program.

The faculty and assisting moderators at the workshops include both PC and Mac users.

PLEASE NOTE: There is an additional registration fee per workshop of \$50 Member/Non member/Other Professional*; \$10 Fellow/Trainee*. This fee includes the ELC 2004 Syllabus CD.

** Letter from Neuroradiology Fellowship Program Director confirming status is required. Letter from place of employment to confirm position is required for Other Professionals.*

NOTE: All ELC Workshops will be held in Room 602-603 (Level 6)

ELC Workshop A: PowerPoint for the Novice

Monday, June 7 10:15 am – 11:45 am

Tuesday, June 8.....8:00 am – 9:30 am

David S. Martin, MD

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. Learn how lecture material can be developed for display using LCD projectors. Learning Objectives of this Workshop include: creating a new presentation from scratch; using the Office and Presentation Assistants; copying, deleting, and modifying the sequence of slides; formatting and editing the text in slides; working with Clip Art, pictures, and other objects; preparing an entire presentation; saving a presentation in normal and HTML formats; and printing audience and speaker notes.

ELC Workshop B: PowerPoint for Advanced Users

Monday, June 7.....3:00 pm – 4:30 pm

Tuesday, June 8 3:00 pm – 4:30 pm

H. Christian Davidson, MD

Richard H. Wiggins, III, 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 sound 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 lecturers will demonstrate how to link one PowerPoint presentation to another to control the flow of information and enable toggling between presentations. Lastly, comments will be made on the appropriate use of multimedia components for keeping a talk interesting yet avoiding audience distraction by too much flash.

ELC Workshop C: Image Manipulation with Photoshop

Tuesday, June 8 10:15 am – 11:45 am

Wednesday, June 9 3:00 pm – 4:30 pm

Richard M. Berger, MD

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



ELC 2004 Workshops & Lectures

ELC Workshop D: Website Creation for the Novice

Wednesday, June 9 8:00 am – 9:30 am

Thursday, June 10 8:00 am – 9:30 am

Richard H. Wiggins, III, MD

This course is geared toward anyone who is beginning to think about creating a website for work or personal use. Through a series of practical demonstrations and hands-on exercises, this Workshop will help you acquire the skills necessary to build and maintain a basic website. Topics to be covered include: how a standard web editor works, how to create a basic web page using images and text, creating links between web pages, formatting text and paragraphs, creating and changing the layout of tables, and putting your pages on the web.

ELC Workshop E: Website Creation for Advanced Users

Thursday, June 10 10:15 am – 11:45 am

Dale A. Charletta, MD

This hands-on 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 (HyperText Markup Language) as well as how to insert XML (eXtensible Markup Language). 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 (file transfer protocol) to a web server. Advanced topics such as DHTML (dynamic HTML), CSS (cascading style sheets), Javascript, Java, Perl, and other languages used for web page creation will also be discussed.

ELC Lectures

The ELC lectures were introduced in 2001 in response to the overwhelming demand for computer education beyond what could be accommodated in small workshops. The ELC lectures focus on topics that are of general interest and in which the hands-on experience is not as crucial to the learning process. ELC lectures are held in one of the main session rooms to accommodate a large audience and are included in the Annual Meeting registration fee. No preregistration or ticket is required for admission.

ELC Lecture A: The Radiologist's Computer: PC and Macintosh Perspectives

Monday, June 7 8:00 am – 9:00 am

Hervey D. Segall, MD

Gregory L. Katzman, MD

Up to date basics of computer hardware and operating systems will be covered, including both the Macintosh and PC platforms. Components inside the computer (e.g. motherboard, processor, chipsets, drives, cards, etc.), peripherals (e.g. monitors, speakers, keyboards, etc.), and lastly connections will be discussed.

ELC Lecture B: PDA's and the Radiologist

Monday, June 7 1:00 pm – 1:30 pm

Richard H. Wiggins, III, MD

Attendees will obtain the current understanding of PDA hardware features, expansion interfaces, and the differences between the various operating systems. The technological future for PDA's will be discussed in light of the rapid evolution of these types of products.

ELC Lecture C: High Speed Connectivity and Networking for Work and Home

Monday, June 7 1:30 pm – 2:00 pm

Gerard J. Muro, MD

Attendees will learn about the different types of high-bandwidth Internet access as well as the advantages and limitations of each. Basic principles in connecting a high-bandwidth Internet connection to a personal use LAN (Local Area network) will also be presented with a discussion of networking for both work and home.

ELC Lecture D: CD & DVD Expertise: What You Need to Know

Monday, June 7 4:40 pm – 5:40 pm

Char Branstetter, MD

Both hardware and software CD topics will be presented for the Macintosh as well as PC platforms, including recommendations for purchase that are based on the speaker's experiences and opinions. Lastly, pros, cons, and caveats of DVD technology will be offered.

ELC Roundtable: Q & A with Today's Speakers

Monday, June 7 5:40 pm – 6:10 pm

Char Branstetter, MD, H. Christian Davidson, MD, John L. Go, MD, Gregory L. Katzman, MD, David S. Martin, MD, Gerard J. Muro, MD, Hervey D. Segall, MD, Richard H. Wiggins, III, MD

The ELC Roundtable offers an open session where the Lecture and Workshop speakers of the day will be available to answer questions in an open forum session.

ELC 2004 Workshops & Lectures

ELC Lecture E: Building a Multimedia Conference Room from Scratch

Tuesday, June 8 1:00 pm – 2:00 pm

Venkata Natarajan, PhD

This lecture will outline the creation of a modern digital multimedia conference room to facilitate more efficient presentation of radiology learning materials. Topics will include video requirements (projection devices, cameras, screens, and monitors) audio systems, teaching aids (laser pointers, lecterns, and interactive screens), presentation devices (computers, VCR/DVD players, slide projectors, overhead projectors, PACS and Workstations), network considerations (LAN and WAN), and overall ergonomics (lighting, soundproofing, seating, and room architecture).

ELC Lecture F: Overview of Digital Cameras and Camcorders

Tuesday, June 8 4:40 pm – 5:40 pm

Richard M. Berger, MD

Richard H. Wiggins, III, MD

Topics include how to pick a digital camera and camcorder, avoiding pitfalls during use, taking pictures and video, transferring the results to your computer, file organization, and image optimization. Recommendations for camera and camcorder purchase will be made based on the speakers' experiences and opinions.

ELC Roundtable: Q & A with Today's Speakers

Tuesday, June 8 5:40 pm – 6:10 pm

Richard M. Berger, MD, H. Christian Davidson, MD, John L. Go, MD, David S. Martin, MD, Venkata Natarajan, PhD, Richard H. Wiggins, III, MD

The ELC Roundtable offers an open session where the Lecture and Workshop speakers of the day will be available to answer questions in an open forum session.

ELC Lecture G: Capturing and Using Image Files

Wednesday, June 9 4:40 pm – 5:10 pm

Richard H. Wiggins, III, MD

The audience will get an appreciation for some of the technical details of digital images, requirements for digital presentations, methods for obtaining digital images, and tricks for making PowerPoint lectures. Recommendations will also be made for image storage and organization.

ELC Lecture H: Synopsis of Scanners: Film, Flatbed, and Slide

Wednesday, June 9 5:10 pm – 5:40 pm

Hervey D. Segall, MD

Gary M. Miller, MD

The various types of scanners for use in daily practice will be discussed, including technical specifications,

connections, and software. Purchase recommendations will also be given based on the speakers' experiences and opinions.

ELC Roundtable: Q & A with Today's Speakers

Wednesday, June 9 5:40 pm – 6:10 pm

Richard M. Berger, MD, Gary M. Miller, MD, Hervey D. Segall, MD, Richard H. Wiggins, III, MD

The ELC Roundtable offers an open session where the Lecture and Workshop speakers of the day will be available to answer questions in an open forum session.

ELC Lecture J: Advanced Image Processing in MRI

Thursday, June 10 1:00 pm – 2:00 pm

Todd B. Parrish, PhD

Neuroradiologists and medical physicists rely heavily on processing of MRI raw image data in order to generate more useful results. Topics presented will include MIP (Maximum Intensity Projection), MPR (Multi-Planar Reconstruction), phase contrast MRA, contrast-enhanced MRA, fMRI, diffusion, and perfusion processing.

ELC Lecture I: Digital Teaching Files: An Overview of Techniques

Thursday, June 10 4:40 pm – 5:10 pm

Gregory L. Katzman, MD

This lecture is directed at the novice, who may be considering constructing electronic digital teaching files on his or her desktop computer, either at work, on a laptop, or at home. Several simple methodologies will be presented, all of which are easily learned and inexpensive. Department wide solutions and networks will not be discussed.

ELC Roundtable: Q & A with Today's Speakers

Thursday, June 10 5:40 pm – 6:10 pm

Dale A. Charletta, MD, Gregory L. Katzman, MD, Todd B. Parrish, PhD, Richard H. Wiggins, III, MD

The ELC Roundtable offers an open session where the Lecture and Workshop speakers of the day will be available to answer questions in an open forum session.

Open Forum with the ELC Chair: What Would You Like for the 2005 ELC?

Friday, June 11 10:00 am – 10:30 am

Gregory L. Katzman, MD



National Library of Medicine

SHORT DEMONSTRATION LECTURES & WORKSHOPS



NLM will be offering demonstrations and hands-on workshops focusing on PubMed® and Medlineplus throughout the ASNR Annual Meeting. PubMed® is the National Library of Medicine's web-based portal to the MEDLINE database. Searchable without charge, PubMed® provides bibliographic access to the health literature, currently containing over 15 million citations to articles written over the past 50 years. NLM also produces Medlineplus, a free consumer-friendly source of up-to-date health information for patients. Visit and consult with expert librarians or test-drive these and other NLM resources.

There is no registration fee for these lectures and workshops. To register for a workshop, please sign up at the ELC/NLM desk located outside Room 602-603 (Level 6).

LECTURES

NLM Lectures are located in Room 611-612 (Level 6).

Monday, June 7.....2:00 pm – 2:30 pm
PUBMED®/MEDLINE Short Demonstration Lecture
Linda Milgrom

Thursday, June 10 2:00 pm – 2:30 pm
PUBMED®/MEDLINE Short Demonstration Lecture
Linda Milgrom

Friday, June 11 10:30 am – 11:00 am
MEDLINEplus Short Demonstration Lecture
Gail Kouame



WORKSHOPS

Room 602-603 (in cooperation with the Electronic Learning Center (ELC) Committee).

Tuesday, June 8 1:30 pm – 2:30 pm
PUBMED®/MEDLINE: Advanced Tips And Tricks
Hands-On Workshop
Linda Milgrom

Wednesday, June 9 1:30 pm – 2:30 pm
PUBMED®/MEDLINE: Advanced Tips And Tricks
Hands-On Workshop
Linda Milgrom

How-To Sessions (As of 5/4/2004)

HOW-TO SESSIONS

In addition to the Technical Exhibition, the leadership of the ASNR is pleased to announce the eighth 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 Luncheon Sessions are scheduled Tuesday, June 8 through Thursday, June 10. How-To Breakfast Sessions are scheduled Monday, June 7 through Friday, June 11. Again in 2004, How-To Session programming will be offered during specific breakfast, lunch and reception sessions.



Friday, June 11 6:50 am - 7:50 am

"Matrix Detachable Coils – Clinical Update"

Fernando Vinuela, MD; Jacques Moret, MD;
Anil Gholkar, MD; Michael J. Alexander, MD



Wednesday, June 9 6:50 am - 7:50 am

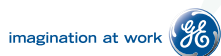
"CTA: State of the Art"

David Enterline, MD

"New Developments and New Agents for Contrast-Enhanced MRI"

William G. Bradley, Jr. MD, PhD, FACR

GE Healthcare



Tuesday, June 8 6:50 am - 7:50 am

"Why 3T MRI Will Replace 1.5T Over the Next Few Years"

William G. Bradley, Jr. MD, PhD, FACR

"Propeller MR Imaging"

Emanuel Kanal, MD

Thursday, June 10 11:50 am - 12:50 pm

"Aneurysm Imaging: Screening, Emergency, and Post-Treatment"

Howard A. Rowley, MD



Thursday, June 10 6:15 pm - 7:15 pm

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 seven years were integrated into this year's format.

The sessions vary and include both didactic presentations and demonstrations, all with a strong practical emphasis. A significant portion of each session is devoted to questions and answers. Indications, problems, and solutions relating to imaging techniques will be addressed including advances in helical CTA, CT perfusion, MDCT applications and MRI of the brain.



Sunday, June 6 6:45 am - 7:45 am

"Combining Functional and Diffusion Tensor Magnetic Resonance Imaging"

Dae-Shik Kim, PhD

Tuesday, June 8 11:50 am - 12:50 pm

"Modern Pediatric Neuroimaging: Function in Addition to Anatomy"

Lidia Nagae-Poetscher, MD

"40 Channel Detector Computed Tomography Use in High Resolution CTA"

George Ebert, MD, PhD

SIEMENS
medical

Wednesday, June 9 11:50 am - 12:50 pm

"New (Year's) Resolutions for Neuro MRI"

A. Gregory Sorenson, MD

Thursday, June 10 6:50 am - 7:50 am



Monday, June 7 6:50 am - 7:50 am

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

Scientific Program Overview *(As of 4/21/2004)*

Meals and Breaks: Breakfasts, Morning and Afternoon Coffee Service, and Box Lunches will be provided throughout the week. **PLEASE NOTE:** 42nd Annual Meeting food service locations vary throughout week based on Technical Exhibit hours and How-to Session programming.

NOTE: Boxed copy signifies concurrent programming.

ASNR 42ND ANNUAL MEETING

Monday, June 7

6:30am - 7:50am

BREAKFAST

6:50am - 7:50am

HOW-TO SESSION BREAKFAST

7:55am - 8:00am

(1) OPENING REMARKS

Charles M. Strother, MD, ASNR President

8:00am - 9:00am

(2) ELC LECTURE A:

THE RADIOLOGIST'S COMPUTER: PC AND MACINTOSH PERSPECTIVES

Hervey D. Segall, MD; Gregory L. Katzman, MD

8:00am - 9:30am

(3) NONACCIDENTAL INJURY (NAI) OF THE DEVELOPING BRAIN: ISSUES, CONTROVERIES, AND THE MIMICS (ASPNR)

8:00am - 8:30am

Clinical and Pathologic Aspects

John A. Plunkett, MD

8:30am - 9:00am

Biomechanics of Traumatic Shaking Injury

Faris A. Bandak, PhD

9:00am - 9:30am

Neuroimaging Aspects

Patrick D. Barnes, MD

8:00am - 9:30am

(4) HEAD AND NECK CARCINOMA: WHAT THE CLINICIANS NEED TO KNOW (ASHNR)

8:00am - 8:30am

Larynx

Suresh K. Mukherji, MD

8:30am - 9:00am

Oral Cavity and Oropharynx

Robert B. Lufkin, MD

9:00am - 9:30am

Nasopharynx

Nancy J. Fischbein, MD

8:00am - 12:00pm

(5) ASNR GRANT WRITING SEMINAR: PRACTICAL TIPS ON GETTING YOUR GRANT FUNDED - PART I

Janet S. Rasey, PhD

9:30am - 10:05am

MORNING BREAK

10:15am - 11:45am

(6) PARALLEL SCIENTIFIC PAPER SESSIONS

Session 6a – Adult Brain: General and High
Field Imaging (ends at 11:50am)

Session 6b – Adult Brain: Cerebrovascular
Disease and Stroke

Session 6c – Head & Neck: General

Session 6d – Pediatrics: Fetal and Neonatal
Imaging

10:15am - 11:45am

(7) ELC WORKSHOP A: POWERPOINT FOR THE NOVICE

David S. Martin, MD; John L. Go MD

11:45am - 12:50pm

LUNCH BREAK

1:00pm - 1:30pm

(8) ELC LECTURE B: PDA's AND THE RADIOLOGIST

Richard H. Wiggins, III, MD

Scientific Program Overview (continued) (As of 4/21/2004)

Monday, June 7 (continued)

1:00pm - 2:30pm

(9) LEARNING DISABILITIES IN CHILDHOOD (ASPNR)

1:00pm - 1:30pm

Overview of Learning Disorders:
Current Concepts, Biological Foundations,
and Research

Bruce McCandliss, PhD

1:30pm - 2:00pm

Functional MR Imaging in Children: Techniques,
Current Usefulness

Bruce McCandliss, PhD

2:00pm - 2:30pm

Pediatric Applications of fMRI

Nolan R. Altman, MD

1:00pm - 2:30pm

(10) CT, MRI AND PET IMAGING IN TREATED NECK (ASHNR)

1:00pm - 1:30pm

Role of PET/CT in Imaging of the Neck

Melanie B. Fukui, MD

1:30pm - 2:00pm

Postoperative Imaging of the Neck

Daniel W. Williams, III, MD

2:00pm - 2:30pm

Posttreatment Imaging of Larynx

David M. Yousem, MD

1:30pm - 2:00pm

(11) ELC LECTURE C: HIGH SPEED CONNECTIVITY AND NETWORKING FOR WORK AND HOME

Gerard J. Muro, MD

2:00pm - 2:30pm

(11A) NATIONAL LIBRARY OF MEDICINE: PUBMED®/MEDLINE SHORT DEMONSTRATION LECTURE

Linda Milgrom

2:30pm - 2:55pm

AFTERNOON BREAK

3:00pm - 4:30pm

(12) PARALLEL SCIENTIFIC PAPER SESSIONS

Session 12a – Adult Brain: Neoplasms
(ends at 4:35pm)

Session 12b – Adult Brain: Cerebrovascular
Disease and Stroke

Session 12c – Head & Neck: General

Session 12d – Pediatrics: General,
Developmental and Congenital
Disorders

3:00pm - 4:30pm

(13) ELC WORKSHOP B: POWERPOINT FOR ADVANCED USERS

H. Christian Davidson, MD;

Richard H. Wiggins, III, MD

4:40pm - 5:40pm

(14) ELC LECTURE D: CD & DVD EXPERTISE: WHAT YOU NEED TO KNOW

Barton F. Branstetter, IV, MD

4:40pm - 6:10pm

(15) TREATMENT OF CNS PEDIATRIC NEOPLASTIC DISEASE: RESPONSE & COMPLICATIONS (ASPNR)

4:40pm - 4:50pm

Overview of Pediatric CNS Neoplasms

Roger Packer, MD

4:50pm - 5:10pm

Neuroradiologists' Approach to Pediatric
CNS Neoplasms

Robert A. Zimmerman, MD

5:10pm - 5:30pm

The Central Role of Neuroimaging in Radiation
Therapy Planning: Delivery & Follow-up

Thomas E. Merchant, DO, PhD

5:30pm - 5:50pm

Role of Chemotherapy & Molecular Targeted
Therapy for Brain Tumors

Roger Packer, MD

5:50pm - 6:10pm

Complications of Radiation and Chemotherapy

Lucy B. Rorke, MD

4:40pm - 6:10pm

(16) STUMP THE STARS (ASHNR)

Panelists: *Patricia A. Hudgins, MD, Suresh K.
Mukherji, MD; H. Ric Harnsberger, MD*



Scientific Program Overview (continued) (As of 4/21/2004)

4:40pm - 6:10pm

(17) ADVANCED IMAGING SEMINAR - DIFFUSION

4:40pm - 5:05pm

Overview of Physiologically - Specific Neuroimaging

Michael W. Weiner, MD

5:05pm - 5:30pm

Basics and Clinical Applications of DWI

P. Ellen Grant, MD

5:30pm - 5:55pm

Diffusion Tensor Imaging (DTI)

Techniques and Terminology

Thomas E. Conturo, MD, PhD

5:55pm - 6:10pm

Diffusion Tensor Imaging (DTI)

Fiber Tracking

Pratik Mukherjee, MD, PhD

5:40pm - 6:10pm

(18) ELC ROUNDTABLE:

Q & A WITH TODAY'S SPEAKERS

Barton F. Branstetter, IV, MD; H. Chrisitan Davidson, MD; John L. Go, MD; Gregory L. Katzman, MD; David S. Martin, MD; Gerard J. Muro, MD; Hervey D. Segall, MD; Richard H. Wiggins, III, MD

6:00pm - 7:30pm

**TECHNICAL EXHIBITOR
WELCOME RECEPTION**

Tuesday, June 8

6:30am - 7:50am

BREAKFAST

6:50am - 7:50am

HOW-TO SESSION BREAKFAST

8:00am - 9:30am

(19) TUMORS (ASPNR)

8:00am - 8:30am

Pediatric Brain Tumor Imaging Protocols and Diffusion Imaging Applications

Tina Young Poussaint, MD

8:30am - 9:00am

Usefulness of MR Spectroscopy in Pediatric Brain Tumors

Kim M. Cecil, PhD

9:00am - 9:30am

MR Perfusion and Pediatric Brain Tumors

Soonmee Cha, MD

8:00am - 9:30am

(20) MDCT IN THE EVALUATION OF SINONASAL DISEASE (ASHNR)

8:00am - 8:30am

Sinus Inflammatory Disease

Yoshimi Anzai, MD

8:30am - 9:00am

Sinus Neoplasms

C. Douglas Phillips, MD

9:00am - 9:30am

Developmental/Congenital Lesions

Anton N. Hasso, MD, FACR

8:00am - 9:30am

(21) ELC WORKSHOP A: POWERPOINT FOR THE NOVICE

David S. Martin, MD; John L. Go MD

8:00am - 12:00pm

(22) ASNR GRANT WRITING SEMINAR: PRACTICAL TIPS ON GETTING YOUR GRANT FUNDED - PART II

Janet S. Rasey, PhD

9:30am - 10:10am

MORNING BREAK

10:15am - 11:45am

(23) PARALLEL SCIENTIFIC PAPER SESSIONS

Session 23a – Adult Brain: Epilepsy

Session 23b – Head & Neck: General

Session 23c – Pediatrics: General, Functional and Vascular Imaging (ends at 11:56am)

Session 23d – Pediatrics: General and Leukoencephalopathy (ends at 11:50am)

Seattle
ASNR 2004

XLVIII

Scientific Program Overview (continued) (As of 4/21/2004)

Tuesday, June 8 (continued)

10:15am - 11:45am

(24) ELC WORKSHOP C: IMAGE MANIPULATION WITH PHOTOSHOP

Richard M. Berger, MD

11:45am - 12:50pm

LUNCH BREAK

11:50am - 12:50pm

HOW-TO SESSION LUNCH

11:50am - 12:50pm

(25) AMERICAN SOCIETY OF PEDIATRIC NEURORADIOLOGY (ASPNR) ANNUAL BUSINESS MEETING (Members Only)

1:00pm - 2:00pm

(26) ELC LECTURE E: BUILDING A MULTIMEDIA CONFERENCE ROOM FROM SCRATCH

Venkata Natarajan, PhD

1:00pm - 2:30pm

27. ENT (ASPNR)

1:00pm - 1:20pm

Congenital Masses of the Head and Neck

Suresh K. Mukherji, MD

1:20pm - 1:40pm

MRS of the Head and Neck

Suresh K. Mukherji, MD

1:40pm - 2:00pm

Pediatric Head and Neck Soft Tissue Masses

Bernadette L. Koch, MD

2:00pm - 2:20pm

Pediatric Head and Neck Osseous Lesions

Bernadette L. Koch, MD

2:20pm - 2:30pm

Discussion

1:00pm - 2:30pm

(28) ADVANCED CT AND MR IMAGING OF THE SKULL BASE (ASHNR)

1:00pm - 1:30pm

Anterior Skull Base Lesions

Timothy L. Larson, MD

1:30pm - 2:00pm

Central and Posterior Skull Base Lesions

H. Ric Harnsberger, MD

2:00pm - 2:30pm

Craniovertebral Junction

Wendy R.K. Smoker, MD, FACR

1:30pm - 2:00pm

(28A) NATIONAL LIBRARY OF MEDICINE: PUBMED®/MEDLINE: ADVANCED TIPS AND TRICKS HANDS-ON WORKSHOP

Linda Milgrom

2:30pm - 2:55pm

AFTERNOON BREAK

3:00pm - 4:30pm

(29) PARALLEL SCIENTIFIC PAPER SESSIONS

Session 29a – Adult Brain: Vascular Imaging (ends at 4:33pm)

Session 29b – Adult Brain: Functional Imaging (fMRI, MSI, MRS, PET)

Session 29c – Adult Brain: New Techniques, Postprocessing/Trauma

Session 29d – Pediatrics: General

3:00pm - 4:30pm

(30) ELC WORKSHOP B: POWERPOINT FOR ADVANCED USERS

H. Christian Davidson, MD;

Richard H. Wiggins, III, MD

4:40pm - 5:40pm

(31) ELC LECTURE F: OVERVIEW OF DIGITAL CAMERAS AND CAMCORDERS

Richard M. Berger, MD;

Richard H. Wiggins, III, MD

4:40pm - 6:10pm

(32) INTERESTING PEDIATRIC CASE SESSION (ASPNR)

4:40pm - 6:10pm

(33) DEVELOPMENTAL LESIONS IN THE HEAD AND NECK (ASHNR)

4:40pm - 5:10pm

Congenital Malformations of the Ear

H. Christian Davidson, MD

5:10pm - 5:40pm

Approach to Imaging of the Globe and Orbit

Clifford J. Belden, MD

5:40pm - 6:10pm

Developmental Anomalies of the Neck

Robert W. Dalley, MD



Scientific Program Overview (continued) (As of 4/21/2004)

4:40pm - 6:10pm

**(34) ADVANCED IMAGING SEMINAR -
PERFUSION, PERMEABILITY
AND BEYOND**

4:40pm - 5:05pm

An Overview of Perfusion Parameters

Howard A. Rowley, MD

5:05pm - 5:30pm

MR Imaging vs. CT Techniques

Michael H. Lev, MD

5:30pm - 5:55pm

Permeability Imaging

James M. Provenzale, MD

5:55pm - 6:10pm

Reactivity and Oxygen Extraction Fraction

David J. Mikulis, MD

5:40pm - 6:10pm

**(35) ELC ROUNDTABLE:
Q & A WITH TODAY'S SPEAKERS**

Richard M. Berger, MD; H. Chrisitan Davidson, MD; John L. Go, MD; David S. Martin, MD; Venkata Natarajan, PhD; Richard H. Wiggins, III, MD

Wednesday, June 9

6:30am - 7:50am

BREAKFAST

6:50am - 7:50am

HOW-TO SESSION BREAKFAST

8:00am - 9:30am

**(36) PERSPECTIVES ON SUBMISSION OF
GRANT APPLICATIONS**

8:00am - 8:30am

Grantsmanship: The Art of Writing a Grant

Colin P. Derdeyn, MD

8:30am - 9:00am

The NIH Review Process

R. Nick Bryan, MD, PhD

9:00am - 9:30am

Research Funding Opportunities for
Neuroradiologists

James M. Provenzale, MD

8:00am - 9:30am

**(37) SPECIAL SESSION: CAN THE PRESENT
PRACTICE OF NEURORADIOLOGY
SURVIVE? MEETING THE CHALLENGES
OF MARGINALIZATION AND CHANGE**

8:00am - 8:05am

Introduction

Victor M. Haughton, MD

8:05am - 8:20am

The End of One-Time Certification

Patricia A. Hudgins, MD

8:20am - 8:40am

The "R" Word?

Robert I. Grossman, MD

8:40am - 9:00am

Reimbursement Rates for Neuroradiology
Procedures

J. Arliss Pollock, MD

9:00am - 9:30am

The Role of the ASNR in the Facilitation of the
Neuroradiology Practice

A. James Barkovich, MD

8:00am - 9:30am

**(38) ELC WORKSHOP D:
WEBSITE CREATION FOR THE NOVICE**

Richard H. Wiggins, III, MD

9:30am - 9:55am

MORNING BREAK

10:00am - 10:15am

(39) ASNR PRESIDENTIAL ADDRESS

Charles M. Strother, MD, ASNR President

Scientific Program Overview (continued) *(As of 4/21/2004)*

Wednesday, June 9 (continued)

10:15am - 11:10am

(40) ASNR AWARDS PRESENTATION

10:15am - 10:30am

Presentation of Gold Medal Awards

Moderators: Charles M. Strother, MD, ASNR President; Victor M. Haughton, MD, Chair, Gold Medal Awards Committee

10:30am - 10:40am

Presentation of 2004 ASNR

Honorary Member Award

Moderator: Norman E. Leeds, MD, Chair, Honorary Member Committee

10:40am - 10:50am

Presentation of 2004 Cornelius G. Dyke Memorial Award

Moderators: Charles M. Strother, MD, ASNR President; Victor M. Haughton, MD, ASNR President-Elect/Program Chair

10:50am - 10:55am

Announcement of 2003 Outstanding Presentation Awards

Moderator: Laurie A. Loevner, MD, Chair, Education Committee

10:55am - 11:10am

Presentation of NER Foundation Award for Outstanding Contribution in Research

Moderator: A. James Barkovich, MD, Chair, NER Foundation

Announcement of 2004 NER Foundation Scholar Award in Neuroradiology Research

Announcement of 2004 NER Foundation/Boston Scientific (formerly Target Therapeutics, Inc.) Fellowship in Cerebrovascular Disease Research

Announcement of 2004 Berlex/NER Foundation Fellowship in Basic Science Research Awards

Moderator: James M. Provenzale, MD, Chair, Research Committee

11:10am - 11:15am

(41) ANNOUNCEMENT OF SYMPOSIUM NEURORADIOLOGICUM (SNR) XVIII/WORLD FEDERATION OF NEURORADIOLOGICAL SOCIETIES

Michael S. Huckman, MD

11:15am - 11:45am

(42) AMERICAN SOCIETY OF NEURORADIOLOGY (ASNR) ANNUAL BUSINESS MEETING *(Members Only)*

11:45am - 12:50pm

LUNCH BREAK

11:50am - 12:50pm

HOW-TO SESSION LUNCH

1:00pm - 2:30pm

(43) NEW IMAGING TECHNIQUES IN SPINE (ASSR)

1:00pm - 1:20pm

New Imaging Techniques in Conventional MR Imaging
Lawrence N. Tanenbaum, MD

1:20pm - 1:40pm

Diffusion Imaging in the Spine
Gordon K. Sze, MD

1:40pm - 2:00pm

Functional MR Imaging in the Spine
Patrick W. Stroman, PhD

2:00pm - 2:20pm

Magnetization Transfer in the Spine
Massimo Filippi, MD

2:20pm - 2:30pm

ASSR 2004 Mentor Award: Prospective Analysis of Clinical Outcomes After Percutaneous Vertebroplasty for Painful Osteoporotic Vertebral Body Fractures
Huy M. Do, MD

1:00pm - 2:30pm

(43A) NEURONEWS: DEVELOPING RESEARCH AND EMERGING TRENDS

1:30pm - 2:30pm

(43B) NATIONAL LIBRARY OF MEDICINE: PUBMED®/MEDLINE: ADVANCED TIPS AND TRICKS HANDS-ON WORKSHOP

Linda Milgrom

2:30pm - 2:55pm

AFTERNOON BREAK



Scientific Program Overview (continued) (As of 4/21/2004)

Wednesday, June 9 (continued)

3:00pm - 4:30pm

(44) PARALLEL SCIENTIFIC PAPER SESSIONS

Session 44a – Adult Brain: Vascular Imaging
in Tumor and Ischemia

Session 44b – Spine: Spinal
Injections/Vertebroplasty

Session 44c – Adult Brain: Functional Imaging
(fMRI, MSI, MRS, PET)

Session 44d – Spine: Trauma and Intervention

3:00pm - 4:30pm

(45) ELC WORKSHOP C: IMAGE MANIPULATION WITH PHOTOSHOP

Richard M. Berger, MD

4:40pm - 5:10pm

(46) ELC LECTURE G: CAPTURING AND USING IMAGE FILES

Richard H. Wiggins, III, MD

4:40pm - 6:10pm

(47) SPINAL VASCULAR IMAGING (ASSR)

4:40pm - 5:00pm

Overview of Vascular Neuroanatomy of the Spine
F. Reed Murtagh, MD

5:00pm - 5:20pm

Contrast-Enhanced MR Angiography of Spinal
Vessels and Vascular Disease
Spyros Kollias, MD

5:20pm - 5:40pm

Elliptic-Centric MR Angiography of Spinal
Vascular Lesions

Richard I. Farb, MD, FRCPC

5:40pm - 6:00pm

3D DSA and the Endovascular Approach to
Spinal Vascular Disease

Ajay K. Wakhloo, MD, PhD

6:00pm - 6:10pm

Discussion

4:40pm - 6:10pm

(48) ADVANCED IMAGING SEMINAR - ADVANCED MR AND MR SPECTROSCOPY

4:40pm - 5:05pm

An Overview of High vs Low Field Imaging
Timothy P.L. Roberts, PhD

5:05pm - 5:30pm

Basic MR Spectroscopy and Clinical
Applications

Jill V. Hunter, MD

5:30pm - 5:55pm

Parallel Imaging in Neuroradiology
Christiane Kuhl, PhD

5:55pm - 6:10pm

Advanced MRSI Techniques
Ulrike Dydak, PhD

5:10pm - 5:40pm

(49) ELC LECTURE H: SYNOPSIS OF SCANNERS: FILM, FLATBED, AND SLIDES

Hervey D. Segall, MD; Gary M. Miller, MD

5:40pm - 6:10pm

(50) ELC ROUNDTABLE: Q & A WITH TODAY'S SPEAKERS

*Richard M. Berger, MD; Gary M. Miller, MD;
Hervey D. Segall, MD;
Richard H. Wiggins, III, MD*

6:00pm - 7:30pm

RECEPTION - "PIKE PLACE MARKET"

Thursday, June 10

6:30am - 7:50am

BREAKFAST

6:50am - 7:50am

HOW-TO SESSION BREAKFAST

Scientific Program Overview (continued) *(As of 4/21/2004)*

Thursday, June 10 (continued)

8:00am - 9:30am

(51) MULTIDETECTOR CT FOR SPINE IMAGING (ASSR)

8:00am - 8:20am

Post Processing and 3D Rendering
for Trauma

Diego B. Nunez, Jr., MD, MPH

8:20am - 8:40am

CT Screening for Cervical Spine Trauma

C. Craig Blackmore, MD, MHS

8:40am - 9:00am

Degenerative Spine Disease Applications

Jeffrey A. Stone, MD

9:00am - 9:20am

Multislice Physics and Radiation Safety

James M. Kofler, Jr., PhD

9:20am - 9:30am

Q & A Session

8:00am - 9:30am

(52) SPINAL VASCULAR INTERVENTIONS (ASITN)

8:00am - 8:30am

Imaging

Kieran P.J. Murphy, MD

8:30am - 9:00am

Pathophysiology

Jacques E. Dion, MD-m

9:00am - 9:30am

Treatment

Christopher F. Dowd, MD

8:00am - 9:30am

(53) ELC WORKSHOP D: WEBSITE CREATION FOR THE NOVICE

Richard H. Wiggins, III, MD

9:30am - 10:10am

MORNING BREAK

10:15am - 11:45am

(54) PARALLEL SCIENTIFIC PAPER SESSIONS

Session 54a – Spine: Degenerative Disk
Disease and Biomechanics

Session 54b – Interventional New Devices
(ends at 11:55am)

Session 54c – Adult Brain: Neoplasms

Session 54d – Spine: General, Spinal Cord

10:15am - 11:45am

(55) ELC WORKSHOP E: WEBSITE CREATION FOR ADVANCED USERS

Dale A. Charletta, MD

11:45am - 12:50pm

LUNCH BREAK

11:50am - 12:50pm

HOW-TO SESSION LUNCH

11:50am - 12:50pm

(56) AMERICAN SOCIETY OF SPINE RADIOLOGY (ASSR) ANNUAL BUSINESS MEETING *(Members Only)*

1:00pm - 2:30pm

(57) DYNAMIC AND UPRIGHT MRI/SCIENCE (ASSR)

1:00pm - 1:20pm

Spinal Instability

Luigi Manfre, MD

1:20pm - 1:40pm

Dynamic Imaging of the Posterior Elements

J. Randy Jenkins, MD, FACR, FEC

1:40pm - 2:00pm

Normal and Abnormal Disks

Jeffrey Silber, MD

2:00pm - 2:15pm

Dynamic Disk Pressure Measurements

Kurt P. Schellhas, MD

2:15pm - 2:30pm

Dynamic Vertebral Body Mechanics

Stephen M. Belkoff, MD

1:00pm - 2:30pm

(58) ATHEROSCLEROSIS (ASITN)

1:00pm - 1:30pm

Patient Selection

Colin P. Derdeyn, MD

1:30pm - 2:00pm

Intracranial Angioplasty/Stenting

Joan C. Wojak, MD

2:00pm - 2:30pm

Cervical Carotid Disease

John J. Connors, III, MD



Scientific Program Overview (continued) (As of 4/21/2004)

Thursday, June 10 (continued)

1:00pm - 2:00pm

(59) ELC LECTURE J: ADVANCED IMAGING PROCESSING IN MRI

Todd B. Parrish, PhD

2:00pm - 2:30pm

(59B) NATIONAL LIBRARY OF MEDICINE: PUBMED®/MEDLINE SHORT DEMONSTRATION LECTURE

Linda Milgrom

2:30pm - 2:55pm

AFTERNOON BREAK

3:00pm - 4:30pm

(60) PARALLEL SCIENTIFIC PAPER SESSIONS

Session 60a – Adult Brain: General

Session 60b – Interventional: Aneurysms

Session 60c – Adult Brain: General and Diffusion Imaging

Session 60d – Adult Brain: General and 3.0T

4:40pm - 5:40pm

(61) ELC LECTURE I: DIGITAL TEACHING FILES: AN OVERVIEW OF TECHNIQUES

Gregory L. Katzman, MD

4:40pm - 6:10pm

(62) ANEURYSMS (ASITN)

4:40pm - 5:10pm

New Devices/Treatments

John D. Barr, MD

5:10pm - 5:40pm

Hemodynamics

Ajay K. Wakhloo, MD, PhD

5:40pm - 6:10pm

Biological Treatment

Yuichi Murayama, MD

4:40pm - 6:10pm

(63) ADVANCED IMAGING SEMINAR - FUNCTIONAL MAPPING

4:40pm - 5:05pm

fMRI Basics

Jonathan H. Burdette, MD

5:05pm - 5:30pm

fMRI Clinical Applications

Andrei I. Holodny, MD

5:30pm - 5:55pm

MEG and MSI

"From Squiggles to Surgery"

Steven M. Stufflebeam, MD

5:55pm - 6:10pm

fMRI Analysis Techniques

James J. Pekar, PhD

5:40pm - 6:10pm

(64) ELC ROUNDTABLE:

Q & A WITH TODAY'S SPEAKERS

Dale A. Charletta, MD; Gregory L. Katzman, MD; Todd B. Parrish, PhD;

Richard H. Wiggins, III, MD

6:15pm - 7:15pm

HOW-TO SESSION RECEPTION

Friday, June 11

6:30am - 7:50am

BREAKFAST

6:50am - 7:50am

HOW-TO SESSION BREAKFAST

8:00am - 9:30am

(65) PARALLEL SCIENTIFIC PAPER SESSIONS

Session 65a – Interventional: Aneurysms
(ends at 9:41am)

Session 65b – Adult Brain: Functional Imaging
(fMRI, MSI, MRS, PET)
(ends at 9:36am)

Session 65c – Interventional: General
(ends at 9:36am)

Session 65d – Adult Brain: Vascular Imaging

9:30am - 9:55am

MORNING BREAK

Scientific Program Overview (continued) *(As of 4/21/2004)*

Friday, June 11 (continued)

10:00am - 10:30am

**(66) OPEN FORUM WITH THE ELC CHAIR:
WHAT WOULD YOU LIKE FOR THE
2005 ELC?**

Gregory L. Katzman, MD

10:00am - 11:30am

(67) STROKE (ASITN)

10:00am - 10:30am

Devices Update

Gary R. Duckwiler, MD

10:30am - 11:00am

Current Imaging of Stroke

J. Pablo Villablanca, MD

11:00am - 11:30am

Thrombolysis Update

Thomas A. Tomsick, MD

10:30am - 11:00am

**(68) NATIONAL LIBRARY OF MEDICINE:
MEDLINE^{plus} SHORT DEMONSTRATION
LECTURE**

Gail Kouame

11:30am-11:45am

CLOSING REMARKS

Victor M. Haughton, MD, ASNR President

ASNR ANNUAL MEETING CONCLUDES

12:00pm-1:30pm

**AMERICAN SOCIETY OF INTERVENTIONAL
AND THERAPEUTIC NEURORADIOLOGY
(ASITN) ANNUAL BUSINESS MEETING**

(Members Only)

& in Sheraton Seattle Hotel and Towers

Juniper Room

June 7 – 11, 2004

ASNR 42nd Annual Meeting



NOTE ABOUT SCANNED IMAGES: Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2004.

Monday Morning

7:55 AM - 8:00 AM

Ballroom 6 B/C

(1) Opening Remarks

— Charles M. Strother, MD, ASNR President

Monday Morning

8:00 AM - 9:00 AM

Ballroom 6 A

(2) ELC Lecture A: The Radiologist's Computer: PC and Macintosh Perspectives

— Hervey D. Segall, MD

— Gregory L. Katzman, MD

Monday Morning

8:00 AM - 9:30 AM

Room 606 - 609

(3) Nonaccidental Injury (NAI) of the Developing Brain: Issues, Controversies, and the Mimics (ASPNR)

(3a) Clinical and Pathologic Aspects

— John A. Plunkett, MD

(3b) Biomechanics of Traumatic Shaking Injury

— Faris A. Bandak, PhD

(3c) Neuroimaging Aspects

— Patrick D. Barnes, MD

Moderator: Patrick D. Barnes, MD

Clinical and Pathologic Aspects

John A. Plunkett, MD

Dr. Plunkett is a general and forensic pathologist at Regina Medical Center in Hastings, MN and also is the Regina Laboratory and Medical Education Director. He has a special interest in the mechanisms and morphology of head injury in infants. Regina is a small community hospital at the junction of the St. Croix and Mississippi Rivers approximately 25 miles southeast of St. Paul. Dr. Plunkett's wife, Donna, is a Software Engineer for Unisys. They have two grown children and two granddaughters. They live on a farm in Welch, MN with seven horses and five cats.

LEARNING OBJECTIVES

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

- 1) Correlate brain injury morphology with injury mechanisms
- 2) Describe and discuss natural disease processes that may be misinterpreted to represent an inflicted trauma.

PRESENTATION SUMMARY

The morphology of trauma in the immature brain and skull, and the emphasis that morphology alone cannot differentiate "accidental" from "inflicted" injury will be discussed. Nontraumatic causes of cerebral damage, including cortical venous thrombosis and meningitis, that have been misinterpreted clinically and pathologically to represent inflicted trauma also will be shown. The mechanism and morphology of brain injury in an infant is fundamentally different from that in an older child or adult. Deformation-induced skull stress and brain strain are the causes for both focal and diffuse brain damage in an infant, while impulsive-loading (acceleration/deceleration) is the mechanism for diffuse brain injury in an adult. Infant head impact at low velocity, below adult thresholds, may cause damage in the brain and extraaxial spaces even without fracture. The injuries may include contusional tears and subdural hemorrhage (SDH) as primary events, and cerebral edema and retinal hemorrhage (RH) as cascade phenomena. If the SDH is large, it tends to be beneath the point of impact, in contrast to the common location in an adult. If the SDH is small, it tends to be "diffuse" and a "thin-film," and the mechanism may not be rupture of bridging veins or "acceleration/deceleration." I will show examples of RH. Specific patterns of RH have been cited as pathognomonic for inflicted trauma. However, the eye only knows that there is a force or energy applied to it, and has no way to differentiate intent in order to initiate its response. Recent studies suggest that the common pathway for RH is functional or structural venous obstruction, and that the characteristics of the bleeding cannot be used to determine the ultimate cause. Traumatic diffuse axonal injury (DAI) rarely if ever occurs in an infant with a deformable skull. Morphologically, it may be impossible to differentiate anoxic DAI from traumatic DAI. The newer immunostains such as beta-APP have confused, not resolved, this issue. Finally, accurate mapping of patterns of brain injury requires large whole-mount histologic sections, a technique rarely used in the United States.

REFERENCES

1. Geddes JF, Hackshaw AK, Vowles GH, Nickols CD, Whitwell HL. **Neuropathology of Inflicted Head Injury in Children. I. Patterns of Brain Damage.** *Brain* 2001;124:1290-1298
2. Geddes JF, Vowles GH, Hackshaw AK, Nickols CD, Scott IS, Whitwell HL. **Neuropathology of Inflicted Head Injury in Children. II. Microscopic Brain Injury in Infants.** *Brain* 2001;124:1299-1306
3. Prange MT, Coats B, Duhaime A-C, Margulies SS. **Anthropomorphic Simulations of Falls, Shakes, and Inflicted Impacts in Infants.** *J Neurosurg* 2003;99:143-150
4. Lantz P. **Perimacular Retinal Folds from Childhood Head Trauma: Case Report with Evidence-Based Enquiry.** *BMJ* 2004 (in press)
5. Goldsmith W, Plunkett J. **A Biomechanical Analysis of the Causes of Traumatic Brain Injury in Infants and Children.** *Am J Forens Med Pathol* 2004 (in press)

Biomechanics of Traumatic Shaking Injury

Faris A. Bandak, PhD

LEARNING OBJECTIVES

- 1) Define the role of biomechanics in distinguishing traumatic shaking injury causation
- 2) Distinguish between infant shaking levels of forces and forces of falls from great heights
- 3) Assess potential mechanisms of injury in infant shaking

PRESENTATION SUMMARY

The Shaken Baby Syndrome as a diagnosis has become somewhat synonymous with inflicted cerebral trauma as indicated by radiological and clinical findings. We will explore shaking injury causation and introduce the biomechanical dimension to the understanding of the mechanisms of traumatic shaking injury. An overview of the biomechanically relevant infant head, neck, and chest anatomy will be given and head loadings commonly ascribed to the Shaken Baby Syndrome addressed. The types of head loadings commonly suspected in causing head injury will be described and head injuries will be categorized according to their biomechanical genesis. The mechanical features leading to a particular injury or set of injuries distinguishing primary and secondary injuries will be described. Primary injuries are taken to be those caused directly by the mechanical insult and secondary injuries to be those comprising the pathophysiologic progression following primary injury. We will discuss the relationship and differences between contact and noncontact loading. From an injury perspective, the noncontact classification is really just a subset of the contact type that generally differs in magnitude, time duration, and in operative biomechanisms of injury. We will address values of "force" and their relationship to major structural failure that can be detectable by imaging.

REFERENCES

1. Caffey J. **On the Theory and Practice of Shaking Infants. Its Potential Residual Effects of Permanent Brain Damage and Mental Retardation.** *Am J Dis Child* 1972;124:161-169
2. Guthkelch AN. **Infantile Subdural Hematoma and Its Relationship to Whiplash Injuries.** *Brit Med J* 1971;2:430-431
3. Johnson, W.H. and Kennedy, J. A., 1961, *Radiographic Anatomy of the Human Skeleton*, Baltimore, Williams and Wilkins
4. Duhaime A-C, Gennarelli TA, Thibault LE, Bruce DA, Margulies SS, Wiser R. **The Shaken Baby Syndrome: A Clinical, Pathological and Biomechanical Study. I** 1987; 66:409-415

Neuroimaging Aspects

Patrick D. Barnes, MD

LEARNING OBJECTIVES

- Upon completion of this session, participants will be able to:
- 1) Review the neuroimaging findings in nonaccidental injury (NAI) as well as in the mimics of NAI
 - 2) Review the role of neuroimaging in the clinical and forensic evaluation of children with suspected nonaccidental injury

- 3) Correlate the neuroimaging findings with neuropathology and biomechanics in NAI vs accidental injury and nontraumatic mimics
- 4) Review the role of the radiologist as a medicolegal consultant and expert witness in cases of alleged NAI

PRESENTATION SUMMARY

One of the most controversial areas of nonaccidental injury (NAI) is the medical and forensic diagnosis of "inflicted" central nervous system (CNS) injury because of its profound impact on medical, social, and legal outcomes for children and families. Some past and more recent cases and reports have brought forward information based upon clinical, surgical, imaging, pathologic, biomechanical, social, and legal observations that raise serious doubt regarding NAI and the "shaken baby syndrome" (SBS) as the cause in all cases of infant CNS injury otherwise attributed to "abuse" using traditional diagnostic criteria for NAI/SBS. This presentation addresses neuroimaging and the role of the radiologist in the clinical care of the child and as a treating or expert medical witness in cases of CNS injury in alleged NAI.

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4. Geddes JF, Tasker RC, Hackshaw AK, et al. **Dural Haemorrhage in Non-Traumatic Infant Deaths: Does It Explain the Bleeding in 'Shaken Baby Syndrome'?** *Neuropathol Appl Neurobiol* 2003;29:14-22
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Monday Morning

8:00 AM - 9:30 AM

Ballroom 6 B/C

(4) Head and Neck Carcinoma: What the Clinicians Need to Know (ASHNR)

(4a) Larynx

— Suresh K. Mukherji, MD

(4b) Oral Cavity and Oropharynx

— Robert B. Lufkin, MD

(4c) Nasopharynx

— Nancy J. Fischbein, MD

Moderators: William P. Dillon, MD
Laurie A. Loevner, MD

Larynx

Suresh K. Mukherji, MD

LEARNING OBJECTIVES

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

- 1) Review the anatomy of the larynx
- 2) Describe the imaging appearance of tumors that involve these specific anatomical sites with a concentration on squamous cell carcinoma
- 3) Develop a checklist of specific information that radiologists should include in their reports for imaging studies performed in patients with tumors of the larynx that will affect directly the treatment and management of these patients

PRESENTATION SUMMARY

The development of modern imaging techniques has altered significantly the treatment and management of malignancies of the upper aerodigestive tract. Important decisions that once were made intraoperatively are made now in advance of surgery by using information from CT and MR imaging. Imaging helps to determine tumor resectability and the extent of surrounding tissue that needs to be resected in order to insure adequate margins. Because it improves the accuracy of staging, pretreatment imaging is accepted as an important adjunct to physical examination in patients with malignancies of the upper aerodigestive tract. Detailed counseling is important for patients with head and neck malignancies, as surgical treatment of tumors in this region results in anatomical alterations that can cause significant lifestyle changes. Properly performed imaging provides detailed information

on the extent and depth of tumors; information that often cannot be ascertained by physical examination. Although mucosal spread is detected better by direct visualization, deep extension is evaluated better by cross-sectional imaging rather than by endoscopy. Pretreatment imaging provides information that may determine whether patients are candidates for organ preservation therapy; either surgical or radiotherapy. Because of advancements in head and neck imaging, some otolaryngologists or radiation oncologists may not be aware of its impact on the treatment and management of squamous cell carcinomas (SCCA) of the larynx. Similarly, some radiologists may not be familiar with the specific information that needs to be conveyed to the referring clinician. The intent of this presentation is to provide guidelines on specific information that needs to be transmitted to the referring otolaryngologist or radiation oncologist and which will alter the treatment of patients with SCCA of the larynx.

Oral Cavity and Oropharynx

Robert B. Lufkin, MD

LEARNING OBJECTIVES

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

- 1) Describe anatomy of the oropharynx and oral cavity
- 2) Identify certain diseases of this area
- 3) Discuss and summarize new developments and future potential of this area

PRESENTATION SUMMARY

The role of CT, MR imaging, and PET in the assessment of the patient with pathology of the oropharynx and oral cavity. Like elsewhere in the head and neck, a thorough understanding of the regional anatomy is essential in adequately interpreting imaging studies. The utility of CT in evaluation of inflammatory conditions, calcification, and fibro-osseous disease will be reviewed. The added value of MR imaging in assessing neoplastic disease, perineural extensions, marrow involvement, and soft tissue pathology also will be covered. The emerging role of PET and CT/PET in defining CT and MR imaging negative early or recurrent malignancies and metastasis as well as potential pitfalls will be emphasized.

Nasopharynx

Nancy J. Fischbein, MD

LEARNING OBJECTIVES

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

- 1) Review the complex anatomy of the nasopharynx
- 2) Review of imaging appearance and radiologic staging of nasopharyngeal carcinoma
- 3) Identify pertinent clinical questions to be answered in a patient with nasopharyngeal carcinoma

PRESENTATION SUMMARY

Cancer of the nasopharynx most commonly occurs in those of Southern Chinese descent, but can occur in any ethnic group. Early identification of this lesion is important, as the location of the nasopharynx adjacent to the central skull base and many critical neurovascular structures means that

unchecked growth of carcinoma in this region may lead to significant clinical deficits and significantly complicate a patient's treatment. Unfortunately, many patients are diagnosed at an advanced stage, after bony involvement, cranial nerve involvement, and/or intracranial extension already has occurred. In this presentation, we will review the normal anatomy of the nasopharynx and adjacent structures. The varied imaging presentations of nasopharyngeal carcinoma (small primary with bulky neck disease, large primary with no evidence of neck disease, skull base involvement, cranial nerve involvement, etc.) then will be reviewed, as will the staging system for this cancer. We also will discuss the optimal imaging evaluation of these patients (CT vs MR imaging, role of PET and PET CT). The difficulties of diagnosing recurrent disease also will be discussed. Pitfalls and pearls of imaging diagnosis that may help the radiologist in his or her approach to the patient with unsuspected, suspected, or known NPC in daily practice also will be reviewed. Nasopharyngeal carcinoma is treated with radiation therapy, with chemotherapy added in all but the earliest stage lesions. Modern treatment involves the use of intensity modulated radiation therapy (IMRT), a technique whereby high-dose radiation can be delivered to a tumor in a highly conformal manner. The push toward more exact anatomically conformal therapy requires radiologists to be thoroughly familiar with the patterns of spread of NPC and aware of the sites where failures may occur. Complete radiologic assessment of tumor is an essential part of the ongoing improvements in local control of nasopharyngeal carcinoma.

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2. Chong VF, Mukherji SK, Ng SH, Ginsberg LE, Wee JT, Sham JS, et al. **Nasopharyngeal Carcinoma: Review of How Imaging Affects Staging.** *J Comput Assist Tomogr* 1999;23(6):984-993
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4. Ng SH, Chong VF, Ko SF, Mukherji SK. **Magnetic Resonance Imaging of Nasopharyngeal Carcinoma.** *Top Magn Reson Imag* 1999;10(5):290-303

Monday Morning

8:00 AM - 12:00 PM

Room 305

(5) ASNR Grant Writing Seminar:
Practical Tips on Getting Your Grant
Funded - Part I

— Janet S. Rasey, PhD

ASNR Grant Writing Seminar: Practical Tips on Getting Your Grant Funded - Part 1

Janet S. Rasey, PhD

Janet S. Rasey, Ph.D. is Professor of Radiation Oncology (now retired) and Director of the Research Funding Service (still active) at the University of Washington Medical Center in Seattle, WA. She holds degrees from the University of Michigan (B.S. in Zoology), Oregon State University (M.S. in Radiological Health) and the University of Oregon (Ph.D. in Biology). Her principle research interests include cancer imaging, radiation biology, and the role of tumor hypoxia in cancer therapy and tumor progression. These research programs have been supported by grants from the NIH, including a MERIT Award (1990-98), and business concerns. In 1989 Dr. Rasey founded the Research Funding Service at UW, which she continues to direct. This service helps investigators in the Health Sciences schools (Medicine, Dentistry, Nursing, Public Health, Pharmacy, and Social Work) find sources of research funds, understand the art of grantsmanship, and learn to write effective grants. Dr. Rasey has received numerous invitations to speak at universities, national scientific meetings, and the NIH on grantsmanship, grant writing, and grant review.

LEARNING OBJECTIVES

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

- 1) Assess the prewriting homework that an applicant needs to do before writing a research grant proposal
- 2) Identify major parts on an NIH grant research plan
- 3) Review specific strategies for writing the different parts of an NIH grant research plan
- 4) Determine what grant reviewers look for in an NIH proposal

PRESENTATION SUMMARY

The objectives of this workshop are to teach the elements of writing a competitive research grant, with emphasis on NIH R01 proposals, and to explain grant review procedures and psychology.

The workshop, presented over 2 days (4 hr/day) is divided into three parts.

Part 1 covers the topic, Before You Write.

Part 2 of the workshop focuses on Writing the Grant. Part 3 covers After You've Written: The Review Process and will examine abilities and skills looked for by reviewers.

Monday Morning

10:15 AM - 11:50 AM

Ballroom 6 B/C

(6a) Adult Brain: General and High
Field Imaging
(Scientific Papers 1 - 12A)

See also Parallel Sessions

(6b) Adult Brain: Cerebrovascular Disease and Stroke

(6c) Head & Neck: General

(6d) Pediatrics: Fetal and Neonatal Imaging

Moderators: David J. Seidenwurm, MD
Michael L. Lipton, MD

Paper 1 Starting at 10:15 AM, Ending at 10:23 AM

Quantitative Analysis of Fiber Density in the Corpus Callosum Using Diffusion Tensor Imaging

Stewart, J. E. • Port, J. D.

Mayo Clinic
Rochester, MN

PURPOSE

MR diffusion tensor imaging coupled with fiber tractography has demonstrated significant utility in the identification and classification of white matter fibers in the brain. Much of the work to date has focused on the qualitative evaluation of brain connectivity in normal and diseased states. The purpose of our research is to develop a quantitative measure of fiber density in the brain.

MATERIALS & METHODS

Spin-echo echo-planar diffusion tensor images are acquired on eight normal volunteers in the axial plane using a GE 1.5T LX MR scanner. A linear multiple regression algorithm statistically estimates the diffusivity constants of the resultant super-tensor (13 axis) data sets, followed by diagonalization and calculation of eigenvalues and eigenvectors. Sixty 128 x 128 images are acquired with a slice thickness of 4.0 mm with a 2.0 mm offset. These images are super-sampled and 60 additional images are interpolated linearly for a total three-dimensional (3D) matrix size of 256 x 256 x 120 with a voxel aspect ratio of 0.9375 x 0.9375 x 1.0 mm. The fractional anisotropy (FA) at each voxel is calculated and 3D curves are constructed from these images in the direction of

the principal eigenvector. These 3D curves are the mathematical equivalent of white matter fibers. Two methods of fiber tract initialization are evaluated. The first technique, uniform spatial initialization (USI), begins new curves in every voxel above a predetermined FA threshold. It is considered by many to be the method of choice for fiber tractography. We have developed a second technique, neuron cell body initialization (NCBI) that predicts the origin of axons at the gray/white interface and initiates 3D curves only from these voxels. The corpus callosum in the images of the eight normal patients are segmented in a semiautomated fashion and divided into ten regions from anterior to posterior. The number of curves (fibers) passing through these regions were counted, normalized, and compared to histologic fiber densities of 20 normal patients as described by Aboitiz, et al., 1992.

RESULTS

The average error for the NCBI algorithm was only 14.2 % vs 24.5% for USI. Maximum fiber density was seen in the genu, connecting prefrontal areas and in the splenium, connecting higher-order processing areas of the temporal and parietal lobes. This is in excellent agreement with histologic data and multiple published neuroanatomical tracing studies. A plot of normalized fiber length in the corpus callosum shows a direct correlation between fiber density and length for the USI algorithm. This undesirable and nonphysiologic feature is a direct result of multiple 3D curves being initiated along existing fiber pathways. The NCBI algorithm significantly reduces this effect and more closely approximates actual corpus callosum fiber density.

CONCLUSION

This study demonstrates the accuracy of the NCBI algorithm in measuring fiber density within the human corpus callosum. While the utility of this algorithm in other white matter tracts has yet to be proven, we believe NCBI should be of significant value in the identification and management of patients with white matter disease in the future.

KEY WORDS: Tractography, diffusion tensor imaging, post-processing

Paper 2 Starting at 10:23 AM, Ending at 10:31 AM

Nuclei and Tracts of the Human Medulla: MR Microscopy at 9.4 T

Naidich, T. P. • Tai, A. W. • Delman, B. N. • Delgado, J. E. • Aguinaldo, J. G. S. • Perl, D. P. • Wolfe, D. E. • Hof, P. R. • Drayer, B. P.

Mount Sinai Medical Center
New York, NY

PURPOSE

The purpose of this study was to explore how well MR microscopy (MRM) could display the fine anatomical detail and 3D organization of the nuclei and fiber tracts of the human medulla.

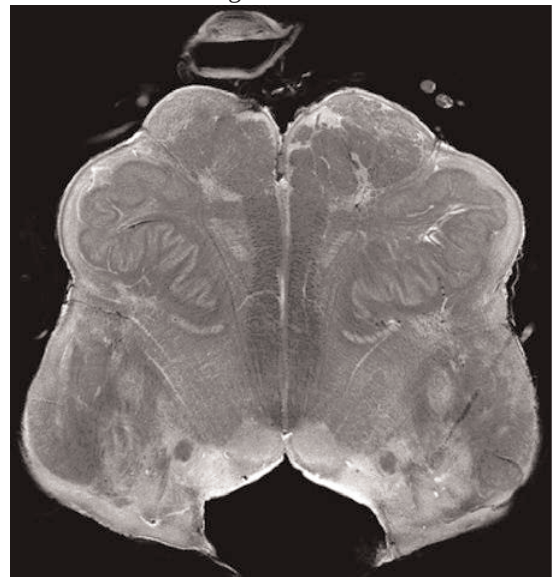
MATERIALS & METHODS

Using previously reported methods (1), the normal nuclei and tracts of the human medulla were displayed in three orthogonal planes at a resolution of 60-70 microns (in plane) by 500 microns (slice thickness) using a Brüker Avance 9.4 T unit,

intermediate-weighted pulse sequences (TR 2000, TE 30, 20 NEX, 3-3.5 cm field of view, 512 x 512 matrix) and three formalin-fixed human medullae from cadavers with no known neurologic disease. Nissl and Luxol fast blue stains provided precise correlation between the MR appearance and the nuclear and fiber tract anatomy of the very same specimens.

RESULTS

MR microscopy convincingly displays the sites, contours, and relationships among the hypoglossal, dorsal vagal, solitary, medial/inferior vestibular, dorsal/ventral cochlear, and spinal trigeminal nuclei and their tracts. The gracilis and cuneatus (medial and lateral) are seen to continue through the internal arcuate fibers, and then decussate to become the medial lemnisci. The dorsal longitudinal, medial longitudinal, and anterolateral fasciculi are defined clearly in relation to these structures. The inferior, the medial accessory and the dorsal accessory olivary nuclei are displayed beautifully in relation to their encompassing amiculum. The pyramids, external arcuate fibers and nuclei, dorsal and ventral spinocerebellar tracts, restiform bodies and medullary striae define the surface. Multiple individual fascicles of the hypoglossal nerve are traced easily through the full thickness of the medulla from their origin in the hypoglossal nucleus dorsally, to course between the inferior and medial olivary nuclei, and then exit ventrally (Figure). Cine display permits the physician to trace individual structures through the length of the stem and helps to integrate their 3D relationships into a coherent image of brainstem structure.



CONCLUSION

MR microscopy at 9.4 T greatly advances the anatomical detail demonstrable in specimen medullae. Those familiar with this anatomy may well be able to appreciate finer anatomical features on clinical images obtained with the higher field 4.7 T, 7 T, and 8 T units now being introduced at selected sites.

REFERENCES

1. Fatterpekar GM, Naidich TP, Delman BN, et al. **Cytoarchitecture of the Human Cerebral Cortex: MR Microscopy of Excised Specimens at 9.4 Tesla.** *AJNR Am J Neuroradiol* 2002;23:1313-1321

KEY WORDS: Medulla, anatomy brain, MR microscopy

Paper 3 Starting at 10:31 AM, Ending at 10:39 AM**Diffusion Tensor Imaging in Pediatric Brainstem Glioma (BSG) Patients, With Neurologic Correlation**

Helton, K. J. • Phillips, N. • Khan, R. B. • Boop, F. A. • Sanford, A. • Ogg, R.

St. Jude's Children's Research Hospital
Memphis, TN

INTRODUCTION

Although magnetic resonance imaging has allowed subcategorization of brainstem tumors by both location, and degree of focality, thereby impacting therapeutic options and prognoses, risk stratification remains unsatisfactory. Diffusion tensor imaging (DTI) is a promising tool to assess the degree of tract involvement, and better define focality.

MATERIALS & METHODS

DTI data (whole head echo-planar, 1.5 Tesla) were analyzed in a retrospective study of 8 patients with diffuse brain stem glioma (BSG), 5 patients with supratentorial tumors, and 5 normal controls. Fractional anisotropy (FA) and apparent diffusion coefficient (ADC) values were calculated from the diffusion tensor for each pixel. FA and ADC were evaluated in regions of interest drawn around the bilateral corticospinal tracts, transverse pontine fibers, and medial lemnisci at the level of the middle cerebellar peduncles, and compared with the corresponding neurological exam.

RESULTS

There were statistically significant differences in both FA and ADC between diffuse BSG patients vs other subjects in the corticospinal tracts, transverse pontine fibers, and medial lemnisci. Where neurological records were available, severity of neurological tract involvement corresponded with decreasing FA and increasing ADC values.

CONCLUSION

Diffusion tensor imaging provided outstanding visualization and quantification of the degree of tract involvement in diffuse BSG patients. The correspondence observed between diffusion parameters and neurological deficits suggests that DTI may be a sensitive indicator of tumor invasion of white matter tracts. Further prospective studies may demonstrate that DTI is useful for delineating tumor focality, and contribute to improved risk stratification in children with this heterogeneous group of tumors.

This paper was selected to receive the Best Paper Award by the Southeastern Neuroradiology Society (SENRS) at its 27th Annual Meeting held in October, 2003.

Robert Ogg, MD will be presenting this paper.

Paper 4 Starting at 10:39 AM, Ending at 10:47 AM**Preliminary Study with High-Resolution SENSE DTI at 3 T: DTI and Fiber Tracking Study in Multiple Sclerosis**

Campi, A.¹ • Staempfli, P.² • Jaermann, T.² • Summers, P.¹ • Goebels, N.¹ • Boesiger, P.² • Valavanis, A.¹

¹University Hospital Zurich, Zurich, SWITZERLAND,
²ETH, Zurich, SWITZERLAND

PURPOSE

To evaluate the ability of DTI fiber tracking to differentiate between the white matter tracts in MS lesions and normal appearing white matter (NAWM).

MATERIALS & METHODS

Five patients (3F, 2M) with clinically definite relapsing-remitting (RR = 3) and secondary progressive (SP = 2) MS and 4 healthy volunteers (2F, 2M) underwent conventional T2-weighted imaging and DTI on a 3 T whole body MR system. The DTI acquisition used a single-shot SE-EPI scheme (matrix/FOV/3 slices/SLT: 96 x 94/200 x 200 x 105 mm/35/3 mm, TE/TR: 71 ms/7751 ms, SENSE reduction factor R = 2.1) with a b-factor of 1000 s/mm² was used along each of six directions, complemented by one scan with b = 0. Mean diffusivity, fractional anisotropy (FA) and color-coded direction of maximum anisotropy maps were generated for each subject. Regions of interest were defined in lesion areas on the T2-weighted imaging of patients and in the contralateral NAWM. Corresponding areas also were defined in the healthy volunteers. Fractional anisotropy was measured in these 2D ROIs, and the ROIs subsequently were used as seed-areas for fiber tracking based on a line propagation algorithm.

RESULTS

Patient 1 (RR MS) is representative. A lesion in the left posterior corona radiata, not detectable 1 month earlier, appeared as a de novo contrast-enhancing lesion. Three weeks later, this lesion no longer enhanced and the T2-weighted imaging abnormality was markedly smaller. T1-weighted imaging showed less hypointensity of this area. Mean FA of this area was 0.50. A second, old lesion in the left parietal white matter was highly hypointense on T1 with FA of 0.15. The depiction rate of fiber tracts in both lesion areas was inferior to that of the contralateral side. However, the newer lesion showed focal reduction of the depiction rate (Figure 1a) while the old lesion showed overall reduction in the depiction rate of fiber tracts (Figure 1b). Similar lesion-related reduction in depiction rate was seen in the other patients.

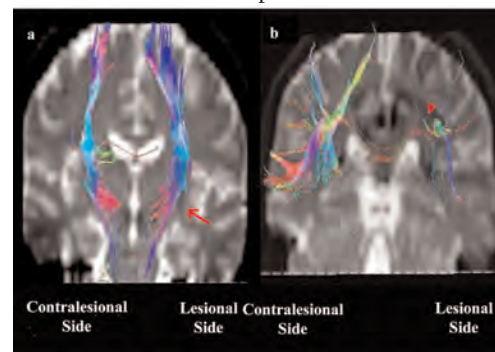


Fig 1 Patient 1. RRMS a. Focal reduction in depiction rate of the projectional fibers adjacent to the corona radiata lesion (arrow). **b.** Generalized reduction in depiction rate of the fibers relating to an old parietal lesion (arrowhead).

CONCLUSION

Our preliminary study suggests that fiber tracking may help in differentiating different pathologic substrates of MS lesion areas. The tracking results, which likely reflect the change in FA values, appear to provide significant supplementary information to the known observed changes in signal intensity on T1-weighted imaging.

KEY WORDS: DTI, fiber tracking, MS

Paper 5 Starting at 10:47 AM, Ending at 10:55 AM**Does Ischemia or Hypoxia Play a Role in Tumofactive Multiple Sclerosis and ADEM?**

Bert, R. J.

Tufts-New England Medical Center
Boston, MA

PURPOSE

To discuss the possible roles of ischemia and/or hypoxia in the pathophysiology of demyelinating disease presenting in the acute phase with tumofactive appearances. We present four (or more) index cases with advanced MR analysis (DWI, PWI, MRS, ?BOLD and conventional MR imaging) of acute demyelinating disease (2 ADEM, 2 MS, 1 case remaining indeterminate; possible additions) leading to this discussion.

MATERIALS & METHODS

Standard MR imaging protocols were obtained in all cases, consisting of sagittal and axial T2 FLAIR, axial T2 TSE, T2 GE, precontrast T1 and postcontrast T1 images. Additional postcontrast coronal T1 images were obtained also. Echoplanar DWI images with B values of 0, 500, and 1000 and tensor ADC maps were obtained in all cases. Single and/or multivoxel MRS (PRESS, TEs of 138 and 270 msec) were obtained in all cases, with short TE (20 or 30 msec) spectra collected in select cases. Echoplanar/GE PWI was obtained in three cases. Fifteen cc's of Gd were administered using a pressure injector, 18 G antecubital vein IV and rate of 5 cc/sec. Fifty image sets (~15 baseline, 35 PC) were obtained. Curves were fitted with standard commercial software (Siemen's Medical) and TTP and CBV standard maps presented. Additional perfusion parameter's were evaluated off-line. In two cases, biopsy results were obtained when tumor and acute infection were included in the differential diagnoses.

RESULTS

All of the index cases demonstrated evidence of anaerobic metabolism, as indicated by elevated lactate on MR spectroscopy. Only a single case demonstrated restricted diffusion based on DWI criteria. On PWI, one case demonstrated generalized hypoperfusion, while another showed central hypoperfusion (decreased CBV, lengthened TTP) with marginal minimally increased perfusion (increased CBV, shortened TTP). Biopsy results from two index cases clearly demonstrated classical active demyelinating disease with perivenular lymphocytic infiltration. Very minimal ring enhancement was demonstrated in two cases on conventional MR spectroscopy.

CONCLUSION

Increased lactate in our index cases is consistent with anaerobic metabolism occurring during demyelinating disease in its active state, when a tumofactive appearance occurs. Neuronal loss occurring with demyelinating disease has been reported previously. We propose, based on these two observations, that hypoxia or ischemia may play a role in the pathophysiology of demyelinating disease in some cases. Decreased perfusion, occurring in the center of the tumofactive lesions, favors ischemia. I suggest that this may result from venous microthrombi (reported by others) or by perivenular restriction of interstitial fluid resorption occurring at the postcapillary venules. Alternatively, mitochondrial dysfunction, based on free radical injury or other inhibitory process, could lead to hypoxia without decreased perfusion (ischemia). I will describe ways of testing these hypotheses in detail at the meeting. Despite the frequent occurrence of lactate in tumofactive demyelinating lesions, restricted diffusion is observed infrequently. Possible explanations of this anomaly will be discussed.

KEY WORDS: Tumofactive ms, demyelinating disease, hypoxia, ischemia

Paper 6 Starting at 10:55 AM, Ending at 11:03 AM**Nuclei and Tracts of the Human Midbrain: MR Microscopy at 9.4 T**

Naidich, T. P. • Delgado, J. E. • Delman, B. N. • Tai, A. W. • Aguinaldo, J. G. S. • Gultekin, H. S. • Perl, D. P. • Hof, P. R. • Drayer, B. P.

Mount Sinai Medical Center
New York, NY

PURPOSE

The purpose of this study was to explore how well MR microscopy (MRM) could display the fine anatomical detail and 3D organization of the nuclei and fiber tracts of the human mesencephalon.

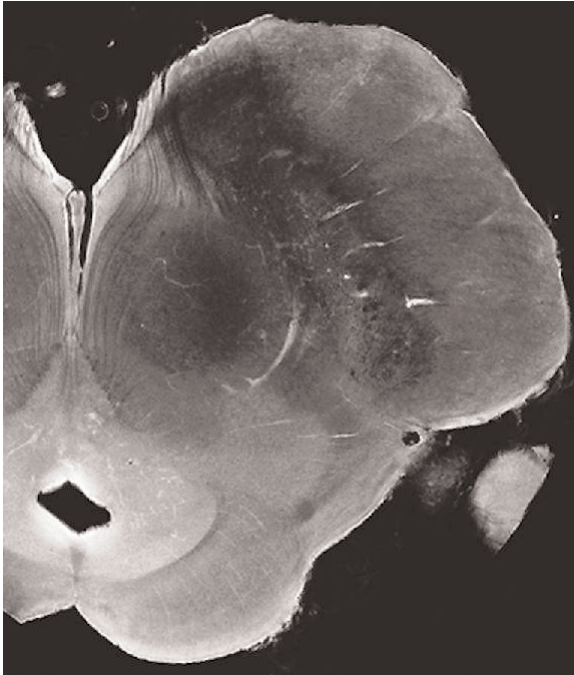
MATERIALS & METHODS

Using previously reported methods (1), the normal nuclei and tracts of the human midbrain were displayed in three orthogonal planes at a resolution of 60-70 microns (in plane) by 500 microns (slice thickness) using a Bruker Avance 9.4 T unit, intermediate-weighted pulse sequences (TR 2000, TE 30, 20 NEX, 3-3.5 cm field of view, 512 x 512 matrix) and three formalin-fixed human mesencephala from cadavers with no known neurologic disease. Nissl and Luxol fast blue stains provided precise correlation between the MR appearance and the nuclear and fiber tract anatomy of the very same specimens.

RESULTS

MR microscopy convincingly displays the individual gray and white strata of the inferior and superior colliculi, their decussations and peduncles, and the intercollicular nuclei. The central gray matter is related to the dorsal and medial longitudinal fasciculi, the nuclei and tracts of the trochlear nerve, the nuclei and tracts of the mesencephalic trigeminal nerve, and the tectospinal tracts. Surrounding these, concentrically, lie the cuneiform and interstitial nuclei, the spinothalamic, dorsal trigeminothalamic, and central tegmental tracts and the anterolateral fasciculi, enclosed by an outer ring

formed by the medial lemnisci and red nuclei. The ventral midline displays the oculomotor and accessory oculomotor nuclei, the multiple individual fascicles of the third nerve (Figure), and the interpeduncular nuclei. The partes compactae and reticulatae of the substantiae nigrae and the tracts of the cerebral peduncles lie ventrolaterally. The trochlear nerves decussate in the superficial medullary velum of the fourth ventricle and emerge just lateral to its frenulum. Cine display permits the physician to trace individual structures through the length of the stem and helps to integrate their 3D relationships into a coherent image of brainstem structure.



CONCLUSION

MR microscopy at 9.4 T greatly advances the anatomical detail demonstrable in specimen mesencephala. Those familiar with this anatomy may well be able to appreciate finer anatomical features on clinical images obtained with the higher field 4.7 T, 7 T, and 8 T units now being introduced at selected sites.

REFERENCES

1. Fatterpekar GM, Naidich TP, Delman BN, et al. **Cytoarchitecture of the Human Cerebral Cortex: MR Microscopy of Excised Specimens at 9.4 Tesla.** *AJNR Am J Neuroradiol* 2002;23:1313-1321

KEY WORDS: Midbrain, anatomy brain, MR microscopy

Paper 7 Starting at 11:03 AM, Ending at 11:11 AM

Detection of Lesions in Encephalomyelitis Disseminata by 2D Fluid-Attenuated Inversion Recovery and Single-Slab 3D Fluid-Attenuated Inversion Recovery Sequence at 3.0 T

Bink, A.¹ • Gaa, J.¹ • Schmitt, M.² • Mugler, J. P.³ • Lanfermann, H.¹ • Zanella, F. E.¹

¹Johann Wolfgang Goethe University, Frankfurt/Main, GERMANY, ²Siemens Medical Solutions, Erlangen, GERMANY, ³University of Virginia, Charlottesville, VA

PURPOSE

Comparison of a conventional 2D FLAIR and a single-slab 3D FLAIR sequence in patients with encephalomyelitis disseminata (ED).

MATERIALS & METHODS

Ten patients with ED were examined by a 2D FLAIR (sagittal, slice thickness: 5 mm, 25 slices, FOV read 220 mm FOV phase 100 %, FA: 42 degree, matrix: 256 x 320, TR: 10 000, TE: 97, bandwidth: 200 Hz/Pixel, TA: 6:22 min) and a single-slab 3D FLAIR sequence (sagittal, resolution: 1.0 x 1.0 x 1.1 mm, 114 slices, FOV read 250 mm FOV phase 85.9 %, matrix: 250 x 256, TR: 6 000, TE: 353, bandwidth: 930 Hz/Pixel, TA: 7:20 min) at 3.0 T (Magnetom TRIO, Siemens Medical Solutions, Erlangen, Germany). Images were analyzed with respect to the following locations: supratentorial: periventricular, subcortical; infratentorial: cerebellum and brain stem.

RESULTS

In the inspected areas, a total of 424 lesions were found using 2D FLAIR while with the 3D FLAIR sequence 739 lesions could be found. With 2D/3D FLAIR sequence were detected periventricular: 163/271, subcortical: 252/444, cerebellum: 6/15 and brain stem: 3/9 lesions. In comparison to 3D FLAIR only 58% supratentorial and 37.5% infratentorial lesions were found by 2D FLAIR sequence. Significantly ($p < 0.05$) more supratentorial lesions were found by the 3D FLAIR sequence.

CONCLUSION

These are the first results using a newly developed single-slab 3D FLAIR sequence at 3.0 T for detection of ED lesions. The performance of the single-slab 3D FLAIR sequence was clearly superior for detection of ED lesions in comparison to a conventional 2D FLAIR sequence.

KEY WORDS: Encephalomyelitis disseminata, 2D/3D FLAIR sequence, 3.0 T

The authors of this work have indicated the following affiliations/disclosures: Siemens Medical Systems: Full-time employment.

Paper 8 Starting at 11:11 AM, Ending at 11:19 AM**Value of Different MR Sequences in the Diagnosis of Creutzfeldt-Jacob Disease**

Kallenberg, K. • Jatrow, U. • Schulz-Schaeffer, W. J. • Poser, S. • Zerr, I. • Knauth, M.

Georg-August University Medical Centre
Goettingen, GERMANY

PURPOSE

The diagnosis of Creutzfeldt-Jacob disease (CJD) is made by autopsy or biopsy of brain tissue. The clinical suspicion is substantiated by technical or chemical tests like EEG or the evaluation of the CSF protein 14-3-3. MR imaging plays an increasingly important role in the diagnosis of CJD, since basal ganglia abnormalities on T2-weighted and proton density- (PD) weighted images have been described. Recently there have been reports of improved diagnostic accuracy by the use of fluid-attenuated inversion-recovery (FLAIR) sequences or by diffusion-weighted imaging (DWI). The aim of our study was to compare the value of different MR sequences (T2-weighted, PD-weighted, FLAIR, DWI) in the diagnosis of CJD.

MATERIALS & METHODS

One hundred fifty-four CJD patients underwent MR exams, 92 neuropathologic diagnosed, 62 clinically classified as CJD through the German CJD surveillance unit (probability of 95%). There was no standard MR protocol so the exams included only 141 T2-weighted, 43 PD-weighted, 84 FLAIR and 44 DWI. The MR images were reviewed for pathologic changes of the basal ganglia, thalamus, and cerebral cortex.

RESULTS

Thirty-eight percent (54/141) of the T2-weighted images showed hyperintense signal changes in the putamen. The corresponding values for the other MR sequences were 58% (25/43) for PD-weighted, 37% (31/84) for FLAIR and 45% (20/44) for DWI, respectively. Comparable results were obtained for changes in the caudate nucleus: 35% (50/141) for T2-weighted, 63% (27/43) for PD-weighted, 48% (40/84) for FLAIR and 64% (28/44) for DWI. Cortical hyperintensities were detected in 8 of 141 cases (6%) on T2-weighted, PD-weighted 19% (8/42), FLAIR 50% (42/84) and DWI 77% (34/44). Thalamic changes were rare: only 5% (7/141) of the patients showed abnormal signal on T2-weighted, respectively 19% (8/43) on PD-weighted, 8% (7/84) on FLAIR and 14% (6/44) on DWI.

CONCLUSION

In comparison PD-weighted and DWI showed only marginally better results in the diagnosis of signal changes in the basal ganglia compared to T2-weighted and FLAIR. However, in the diagnosis of cortical changes in CJD, both FLAIR and DWI were clearly superior to the other MR techniques. Diffusion-weighted imaging was the most sensitive tool in the detection of cortical changes in CJD.

KEY WORDS: Creutzfeldt-Jacob disease, MR sequences, diffusion-weighted imaging

Paper 9 Starting at 11:19 AM, Ending at 11:27 AM**Quality Assessment for Routine Clinical MR Spectroscopy**

Lindquist, D. M.¹ • Glasier, C. M.²

¹University of Arkansas for Medical Sciences, Little Rock, AR, ²Arkansas Children's Hospital, Little Rock, AR

PURPOSE

One of our clinical spectroscopy exams failed due to instrumental problems. We felt that this could be prevented with regular quality control scans. Several papers have addressed quality control in MR spectroscopy for research sites. However, these approaches to quality control require special phantoms and procedures that are difficult for purely clinical sites to implement. Quality control at these sites is equally important. This paper presents a simple protocol for weekly quality control monitoring.

MATERIALS & METHODS

We use the standard head coil to collect an axial image of a commercial MR spectroscopy phantom. Then we place an 8 cm³ voxel in each of three regions along a diagonal within the phantom in the order center, upper right quadrant, and bottom left quadrant. These correspond roughly to the positions of the thalamus, frontal lobe, and occipital lobe in patients. We acquire 35 ms and 144 ms echo-time spectra with a repetition time of 2000 ms. After we acquire the spectra, we acquire a voxel image using the same sequence with the 35 ms echo time and a shorter repetition time. The total time to acquire the data is about 30 minutes. We determine the image uniformity of the axial localizer in accordance with the American College of Radiology method (1). We determine the quality of the localization by measuring the relative intensities of the signal from the voxel and from any surrounding artifacts. We also compare the size of the artifact with the size of the voxel. We analyze the spectra using the manufacturer's automated software, which reports peak heights for N-acetylaspartate, creatine, choline, myo-inositol, and water normalized for receiver gains and line width. We record the percent image uniformity, the signal intensities, and sizes of the voxel and any artifacts in a logbook. We also record the line width of water as reported by the scanner and the peak heights of N-acetyl aspartate, creatine, choline, myo-inositol, and water. Weekly values are compared to preceding entries to ensure that the instrument performance does not change significantly over time.

RESULTS

The average percent deviation for the 35 ms echo time data was 7.23% and the average percent deviation for the 144 ms echo time data was 4.55%. We also found that the system consistently reported larger values for the peaks along the diagonal from the upper right to the lower left. This variation in peak heights corresponded to the image inhomogeneity and was not statistically significant. Voxel contamination was minimal.

CONCLUSION

The data from the phantom are reproducible and provide an indication of the stability and reliability of the instrument. The quality control protocol described here is easy to implement, requires minimal scan time, requires minimal time to analyze, and provides a reliable assessment of the instrument performance over time. Since implementing this procedure, we have had no further problems with poor clinical spectra due to instrument problems.

REFERENCES

1. **Phantom Test Guidance for the ACR MRI Accreditation Program.** American College of Radiology 2000;16-18

KEY WORDS: Quality control, MR spectroscopy

Paper 10 Starting at 11:27 AM, Ending at 11:35 AM

Susac's Syndrome: MR Imaging Evaluation of 24 Patients

Sonne, D. C.¹ • Gean, A. D.¹ • Glastonbury, C. M.¹ • Murtagh, F. R.² • Susac, J. O.³

¹University of California San Francisco, San Francisco General Hospital, San Francisco, CA, ²University of South Florida, Tampa, FL, ³Neurology and Neurosurgery Associates, Winter Haven, FL

PURPOSE

Susac's syndrome (SS) is a self-limited microangiopathy involving the brain, retina, and cochlea, which is thought to be immune-mediated. Diagnosis is based on a clinical triad consisting of encephalopathy, branch retinal artery occlusions, and hearing loss. Because the disease typically affects young women, and the imaging findings include multifocal periventricular white matter (WM) lesions with involvement of the corpus callosum (CC), SS may be misdiagnosed as multiple sclerosis (MS) or acute disseminated encephalomyelitis. The goal of this study was to evaluate the MR imaging manifestations of SS, and to identify findings that may distinguish it from other white matter diseases.

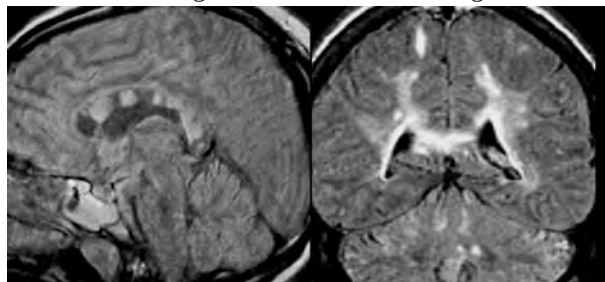
MATERIALS & METHODS

The MR images of 24 patients with clinically confirmed SS were reviewed. The studies included at least T2-weighted or FLAIR sequences. Lesions were categorized by location (CC, supratentorial WM, basal ganglia and thalami (BG), brainstem, cerebellum), signal characteristics, and morphology. Follow-up imaging in 2/3 of patients ranged from 2-21 months.

RESULTS

All patients had multifocal supratentorial WM lesions with involvement of the CC. In the early stages of the disease, the CC lesions were noted to have a round or "snowball" appearance. The majority of these lesions involved the central callosal fibers with relative sparing of the peripheral fibers and callosal undersurface. Seventy-three percent had involvement of the BG, which was sometimes the dominant imaging finding and coincided with or followed the development of CC lesions. Other common locations included the cerebellum (both white and gray matter - 60%) and brainstem (73%). Ninety percent of patients showed scattered punctate leptomeningeal or parenchymal contrast enhancement. In addition to the focal lesions, diffuse ill-defined T2 hyperin-

tensity was noted throughout the background supratentorial WM. Importantly, many of the distinguishing features of MS were not seen. For example, the halo of bright T1 signal was not observed, CC involvement was disproportionate to that of the supratentorial WM, and the central pons was involved to an equal or greater extent than the middle cerebellar peduncles. Follow-up studies showed residual cavitary lesions within the CC. Global cerebral volume loss and marked CC thinning were seen in the late stage of disease.



CONCLUSION

MR imaging of SS may show a distinctive pattern of multifocal supratentorial WM lesions that always involve the CC (typically the central fibers). In the early stages of the disease, the lesions may have a round or "snowball" morphology. BG lesions may be the dominant finding and be present concurrently with or develop subsequently to the CC lesions. There is frequent involvement of the cerebellum and brainstem, as well as frequent contrast enhancement. All of these characteristics should help differentiate SS from MS. In the chronic stage, however, the imaging findings may overlap with demyelinating diseases, thus making a specific diagnosis more difficult.

REFERENCES

1. Susac JO. **Susac Syndrome: The Triad of Microangiopathy of the Brain and Retina with Hearing Loss in Women.** *Neurology* 1994;44:591-593

KEY WORDS: White matter, corpus callosum, demyelination

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

MR Spectroscopic and Perfusion Imaging to Differentiate Tumefactive Plaque from Malignant Tumor

Taing, B. • Pomper, M. G. • Barker, P. B.

The Johns Hopkins University School of Medicine
Baltimore, MD

PURPOSE

Patients presenting with a brain mass often undergo stereotactic biopsy for characterization prior to resection. Tumefactive plaques due to multiple sclerosis (MS) often mimic malignant lesions such as gliomas. In an attempt to avoid biopsy, we used proton MR spectroscopic (MRS) and perfusion (rCBV) imaging to differentiate tumefactive plaque from glioma in patients presenting with a solitary brain mass.

MATERIALS & METHODS

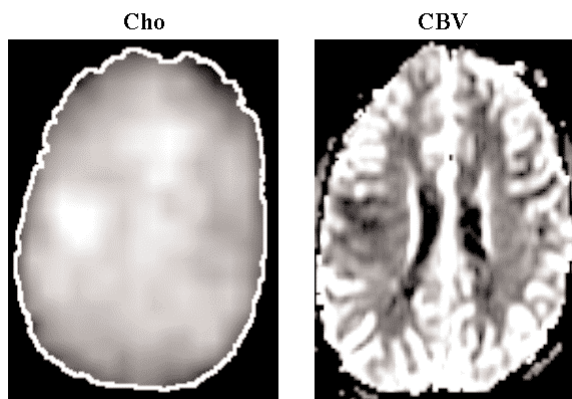
Two patients, each with a brain mass of unknown etiology, presented for MR imaging prior to stereotactic biopsy. Clinically, patient 1 presented with slurred speech and patient 2 presented with a tonic-clonic seizure. In addition to

conventional MR imaging, the patients underwent MRS (TE = 280) (1) and rCBV imaging (2, 3). Parametric maps indicating choline (Cho), creatine (Cr) and n-acetylaspartate (NAA) concentrations (arbitrary units) were generated as were maps indicating rCBV (mL/100 g brain). The maps were analyzed by visual inspection.

RESULTS

The metabolite maps in patient 1 demonstrated increased choline both within the lesion, in regions adjacent to the lesion, and in the contralateral hemisphere. The corresponding rCBV map showed decreased CBV within the lesion compared to contralateral white matter. The metabolite maps in patient 2 showed increased choline only within the lesion, which also showed normal rCBV. Despite elevated choline within the masses of both patients, the normal or reduced rCBV taken together with the clinical data provided sufficiently compelling justification to obviate biopsy in each case. Furthermore, the multifocal and contralateral increases in choline in patient 1 provided even greater confidence that the mass was a tumefactive plaque rather than a glioma. Follow-up MR imaging studies in patients 1 and 2 showed a decrease in size and stability of the original mass, respectively.

Patient 1: Cho and rCBV maps



CONCLUSION

Multiparametric clinical MR imaging can enable the diagnosis of tumefactive plaque with sufficient confidence such that brain biopsy can be avoided.

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2. Wityk RJ, Goldsborough MA, Hillis A, Beauchamp N, Barker PB, Borowicz LM, Jr., et al. **Diffusion- and Perfusion-Weighted Brain Magnetic Resonance Imaging in Patients with Neurologic Complications after Cardiac Surgery.** *Arch Neurol* 2001;58(4):571-576
3. Cha S, Pierce S, Knopp EA, Johnson G, Yang C, Ton A, et al. **Dynamic Contrast-Enhanced T2*-Weighted MR Imaging of Tumefactive Demyelinating Lesions.** *AJNR Am J Neuroradiol* 2001;22(6):1109-1116

KEY WORDS: Multiple sclerosis, MR spectroscopy, perfusion

Paper 12 Starting at 11:40 AM, Ending at 11:45 AM

Tacrolimus-Induced Myelinolysis: Involvement of the Cerebellar Peduncle and Corpus Callosum on Diffusion-Weighted Imaging

Moritani, T. • Ketonen, L. • Hiwatashi, A. • Wang, H. • Ekholm, S. • Westesson, P.

University of Rochester
Rochester, NY

PURPOSE

To report a case of tacrolimus-induced myelinolysis, involving the cerebellar peduncle and corpus callosum on diffusion-weighted imaging.

MATERIALS & METHODS

A 54-year-old man with end-stage liver disease secondary to hepatitis C and hepatocellular carcinoma underwent a liver transplant 1 month earlier. He presented with new-onset slurred speech and confusion that started 5 days before MR imaging. He had taken antifungal and antibiotic therapy, steroids, and tacrolimus after the liver transplant. His confusion was alleviated after the discontinuation of tacrolimus. He has a history of hypertension, esophageal varices, cholelithiasis, degenerative joint disease of both knees, and left-sided Bell's palsy. He has no significant family history. Laboratory data showed no abnormality except for an anemia. Diffusion-weighted imaging and ADC maps ($b = 0, 1000 \text{ sec/mm}^2$, 3 orthogonal orientations) were obtained. MR imaging included T1, T2 and Gd-enhanced T1-weighted, and FLAIR images.

RESULTS

T2 and FLAIR images showed multiple hyperintense lesions in the pons, bilateral middle cerebellar peduncles, the splenium of the corpus callosum, and periventricular and deep white matter. DWI revealed mildly hyperintense lesions in the central portion of the pons associated with increased ADC ($0.98 \times 10^{-3} \text{ mm}^2/\text{s}$), which may represent vasogenic edema. In bilateral middle cerebellar peduncles and the splenium of the corpus callosum, diffusion-weighted imaging demonstrated round or oval hyperintense lesions associated with decreased ADC ($0.36\text{-}0.56 \times 10^{-3} \text{ mm}^2/\text{s}$), representing cytotoxic edema. These findings are consistent with tacrolimus-induced myelinolysis.

CONCLUSION

Diffusion-weighted imaging clearly shows involvement of the pons, cerebellar peduncles, and corpus callosum in tacrolimus-induced myelinolysis. We discuss the pathophysiology of tacrolimus-induced myelinolysis.

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1. Mangat KS, Sherlala K. **Cerebellar Peduncle Myelinolysis: Case Report.** *Neuroradiology* 2002;44:768-769
2. Ravaioli M, Guarino M, Stracciari A, et al. **Speech Disorder Related to Tacrolimus-Induced Pontine Myelinolysis after Orthotopic Liver Transplantation.** *Transpl Int* 2003;16:507-509

KEY WORDS: Diffusion-weighted imaging, cerebellar peduncle, corpus callosum

Paper 12A Starting at 11:45 AM, Ending at 11:50 AM**Reading Brain CT Scans On Computer Displays: Is There An Optimum Image Display Rate?**

Mamourian, A. C. • Khwaja, A. B. • Saykin, A. J. • Wishart, H. A. • McDonald, B. C. • Johnson, D. P.

Dartmouth Hitchcock Medical Center
Lebanon, NH

PURPOSE

Filmless radiology departments using computer workstations have fundamentally altered the way that radiologists read cross sectional examinations. Instead of viewing multiple images displayed simultaneously, the images are usually viewed individually and for most studies, rapidly. Current computers allow rapid display with frame rates of eight frames a second or more. We wondered how this capability of rapid review affects the accuracy of reading of head CT scans. We designed a study to test our hypothesis that more false negatives would occur at frame rates above two per second even though the workstation technology allow much higher rates.

MATERIALS & METHODS

Ten study subjects were shown one of four sets of twelve head CT scans of varying difficulty. Each case was accompanied by limited but appropriate history and was displayed at a frame rate of either one slice every two seconds, two per second, five per second, or eight per second. Each of the four sets of images included all the same cases but all four rates were randomly assigned to each of the four sets. Two normals were in the mix of twelve cases. The abnormalities varied in difficulty and one case had two unrelated findings. The images were stored on a CD and displayed on a high resolution laptop liquid crystal display. Prior to viewing the cases the subjects were asked to choose which of the frame rates they usually use to view images from a choice of the four rates which were displayed simultaneously. The case images were displayed only once with no option to go back and review individual images. The data sheet allowed the subject to rate their confidence level for their diagnosis in each case as well as their comfort level with the specific display rate for each case. The subjects were all either staff radiologists, residents, or fellows in our program. These included two CAQ neuroradiologists, one first year radiology resident on a neuro rotation, three third year residents, two fourth years, one CVIR fellow and one cross sectional fellow.

RESULTS

There was no significant difference in the accuracy of the readers between the four display rates. Their confidence level was lower for the abnormalities at the higher rates but their confidence level for the normals decreased at the slower rates. Four of the subjects chose the rate of five per second as their usual rate, four chose two per second and two chose one every two seconds. None of the subjects correctly identified the second abnormal findings in the case with two unrelated abnormalities any speed.

CONCLUSION

Radiologist can acquire and integrate a surprising amount of diagnostic information at display rates up to eight images a second. While there did not appear to be a significant difference in their accuracy at the different display rates, confidence levels decreased at the fastest and slowest rates. Multiple lesions present a potential pitfall however.

Abnormal

Speed*	Number	Accuracy		Confidence**		Comfort***	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
0.5	24	0.75	0.44	12.1	20.8	46.7	18.7
2	26	0.69	0.47	16.6	26.3	71.6	19.2
5	26	0.75	0.45	21.5	27.4	85	12.6
8	24	0.67	0.48	21	25.7	92.5	12.3

Normal

Speed*	Number	Accuracy		Confidence**		Comfort***	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
0.5	6	0.83	0.41	60.8	12.7	74.5	21
2	4	1	0	66.3	0.5	82	17.2
5	4	1	0	72.5	12.3	80.3	21.8
8	6	0.67	0.52	53.5	16.6	97	4.1

*Speed is given as Images/Second

**Confidence Scale: 0 = Definitely Abnormal, 100 = Definitely Normal

***Comfort Scale: 0 = Way too Slow, 50 = Perfect Speed, 100 = Way too Fast

KEY WORDS: Filmless

Monday Morning

10:15 AM - 11:45 AM

Ballroom 6 A

(6b) Adult Brain: Cerebrovascular Disease and Stroke
(Scientific Papers 13 - 23)

See also Parallel Sessions

(6a) Adult Brain: General and High Field Imaging

(6c) Head & Neck: General

(6d) Pediatrics: Fetal and Neonatal Imaging

Moderators: Ellen G. Hoeffner, MD
Eric J. Russell, MD, FACR

Paper 13 Starting at 10:15 AM, Ending at 10:23 AM**Accuracy of Dynamic Perfusion CT with Deconvolution in Detecting Acute Hemispheric Stroke**

Wintermark, M.^{1,2} • Fischbein, N. J.² • Smith, W. S.² • Ko, N. U.² • Quist, M.³ • Dillon, W. P.²

¹Lausanne University, Lausanne, SWITZERLAND,

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

³Philips Medical Systems, Best, NETHERLANDS

PURPOSE

Dynamic perfusion CT (PCT) with deconvolution produces multiple maps: time-to-peak (TTP), mean transit time (MTT), regional cerebral blood flow (rCBF), and regional cerebral blood volume (rCBV). Computer programs implementing thresholds also have been used to create automated maps detailing infarction and ischemic penumbra. All these maps are interpreted with noncontrast CT (NCT) in patients with suspected stroke. The goal of this study was to determine the accuracy of PCT maps in comparison to noncontrast CT, in patients presenting with suspected acute hemispheric stroke.

MATERIALS & METHODS

Forty-six patients were enrolled in our study, who had suspected hemispheric stroke of 12-hours duration or less and underwent NCT and dynamic PCT on admission, as well as follow-up CT or MR scan. NCT examinations were reviewed by two observers for stroke signs. PCT maps were reviewed by the same observers for TTP, MTT, rCBF, and rCBV abnormalities. Sensitivity, specificity, and accuracy, as well as interobserver agreement, were calculated and compared with Wilcoxon tests. NCT and PCT also were reviewed for the stroke extent according to ATLANTIS and ASPECTS-derived methods. Finally, sensitivity, specificity, and accuracy of a computerized automated map of infarct and penumbra were evaluated for the detection and the extent of brain ischemia.

RESULTS

PCT maps have a significantly higher accuracy than NCT in the detection of stroke (75.7% to 86.0% vs 66.2%, $p < 0.01$). MTT maps are significantly more sensitive than NCT (77.6% vs 69.2%, $p < 0.01$). rCBF and rCBV maps are significantly more specific than NCT (90.0% for rCBF / 92.7% for rCBV vs 65.0% for NCT, $p < 0.01$). With respect to the stroke extent, PCT maps are significantly more sensitive than NCT (kappa up to 94.4% vs 42.9%, $p < 0.01$), and also show a significantly higher interobserver agreement (up to 0.763). The sensitivity, specificity, and accuracy of the computerized automated map of ischemia were 68.2%, 92.3%, and 88.1% for the detection of brain ischemia, and 72.2%, 91.8%, and 87.9% for the extent of brain ischemia.

CONCLUSION

Dynamic PCT maps are more accurate than NCT in the detection of hemispheric strokes. Despite limited spatial coverage, PCT is accurate in showing strokes of more than one third of the MCA territory.

KEY WORDS: Perfusion CT, acute stroke, accuracy

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of perfusion CT prototype software made by Philips Medical Systems for brain perfusion assessment.

The authors of this work have indicated the following affiliations/disclosures: Philips Medical Systems: Employee.

Paper 14 Starting at 10:23 AM, Ending at 10:31 AM**Dynamic Perfusion CT in the Management of Acute Ischemic Stroke: Diagnostic Accuracy and Patient Selection for Intraarterial Thrombolysis**

Gasparotti, R. • Mardighian, D. • Pavia, M. • Pinelli, L. • Florio, S. • Liserre, R. • Magoni, M.

University of Brescia

Brescia, ITALY

PURPOSE

There is increasing evidence that patient selection for acute stroke therapy based on cerebral hemodynamics may lead to expansion of the therapeutic window, improved outcomes, and lower complication rates. Perfusion CT (PCT) was performed in acute stroke to determine its clinical utility in the evaluation of patients who undergo intraarterial thrombolysis.

MATERIALS & METHODS

First-pass double-section PCT was performed in 61 patients, with acute hemispheric stroke within 5 hours from the onset of symptoms. Time-to-peak (TTP), relative mean transit time (rMTT), relative cerebral blood volume (rCBV) and cerebral blood flow (rCBF) maps were computed offline with a commercial software. Infarct "core" was defined as the lesion area identified on CBF maps. TTP maps identified the sum of ischemic penumbra and core. Regions of interest (ROI) were placed manually in ACA, MCA, and PCA territories of both hemispheres, obtaining relative indices. Neurologic status was assessed at admission (National Institutes of Health Stroke Scale; NIHSS) and on day 90 (modified Rankin Score; mRS). Twenty patients were selected for intraarterial thrombolysis with superselective injection of Urokinase and mechanical thrombus fragmentation, on the basis of clinical ($10 < \text{NIHSS} < 30$) and angiographic criteria (8 carotid T occlusions, 2 ICA occlusions + MCA embolism, 10 MCA occlusions). Evolution of the ischemic regions was assessed by comparing PCT maps with follow-up CT at 21 days.

RESULTS

Noncontrast CT had 64% sensitivity and 100% specificity in detecting early ischemic changes, TTP maps 98% sensitivity and 80% specificity, CBV and CBF maps 75% sensitivity and 100 % specificity. Two PCT patterns were identified: A) Corresponding perfusion deficits in the 4 maps, indicating

absence of ischemic penumbra; B) TTP/CBF mismatch, indicating presence of ischemic penumbra. In 12 of 31 untreated patients with pattern A the final infarct size matched the initial perfusion deficit in 100% of subjects (NIHSS 15.71 ± 6.62). In 3 of 20 treated patients with pattern A, despite arterial recanalization, infarct size equalled the initial perfusion deficit (mRS 4 n = 2, mRS 6 n = 1). In 19 of 31 untreated patients with pattern B infarct size matched ischemic penumbra in 6 cases (NIHSS 8.5 ± 6.2). In 17 of 20 treated patients with pattern B the final infarct size matched the ischemic core only when arterial recanalization occurred (n = 13) (mRS ≤ 2 n = 6, mRS 3-5 n = 7), while infarct size equalled the penumbra in the remaining 4 with no recanalization (mRS 3-5 n = 3, mRS 6 n = 1). The quantitative analysis of the ischemic ROIs showed a statistically significant difference between core (DTTP 13.57 ± 7.55 , rCBV 0.61 ± 0.27 , rCBF 0.37 ± 0.28) and penumbra (DTTP 3.13 ± 2.80 , rCBV 1.14 ± 0.27 , rCBF 0.74 ± 0.20) (p < 0.001).

CONCLUSION

The study demonstrates the elevated diagnostic accuracy of PCT, which is able to detect perfusion deficits in acute ischemic stroke before morphologic changes can be depicted at noncontrast CT. A multiparametric assessment of the perfusion deficits can predict the size and location of the cerebral infarction and represents a valuable tool for the selection of patients with ischemic penumbra who can benefit from intraarterial thrombolysis.

KEY WORDS: Perfusion CT, stroke, thrombolysis

Paper 15 Starting at 10:31 AM, Ending at 10:39 AM

CT Perfusion in Acute Stroke: Functional Indicators of Tissue Viability

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PURPOSE

To determine thresholds of cerebral blood flow (CBF) and cerebral blood volume (CBV) to separate viable from infarcted brain tissue in acute stroke.

MATERIALS & METHODS

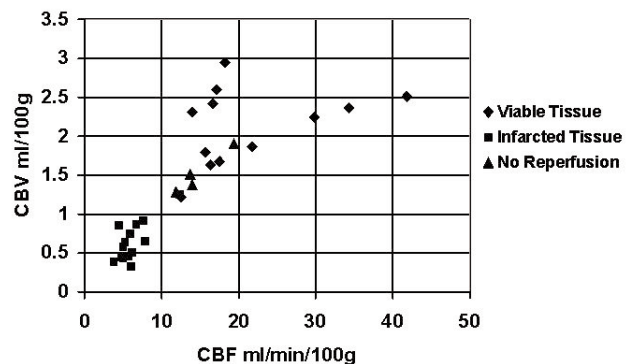
Within 6 hours of acute stroke onset 11 patients were recruited into a prospective study involving CT angiography (CTA) and CT perfusion (CTP) studies in addition to anatomical brain CT (before and following contrast) at admission, 24 hours and 4-7 days later. Each CTP study consisted of a 45 sec cine (continuous) scan with GE Light Speed scanners following injection of 40-50 ml of contrast at a rate of 3-5 ml/sec. This scan covered basal ganglia and lateral ventricles with either four 5 mm or two 10 mm slices using 80 kVp, 190 mA, 1 sec rotation speed, and injection delay of 3-5 sec. CT angiography studies covered from the carotid bifurcations up through the whole head. While noncontrast CT was done with CTA and CTP for the first two studies, at the last

follow-up, either nonenhanced CT scan or MR diffusion-weighted imaging, T1- and/or T2-weighted images were obtained to demonstrate infarction. CTP software (GE Medical Systems) calculated parametric maps of CBF and CBV from the CTPs. For each CTP study, an artery time-density curve (TDC) was obtained from a contralateral artery while using a vein TDC from superior sagittal sinus. Baseline CT and/or MR images and at 4-7 days were registered to each other. Infarcted regions as shown by CT or MR images were outlined manually and regions of interest transferred onto baseline CBF and CBV maps determining the mean CBF and CBV. For comparison, regions adjacent to infarcted regions also were defined and their mean baseline CBF and CBV determined.

RESULTS

Figure plots mean CBV vs CBF of all investigated regions. Infarctions had CBF below 12.5 ml/min/100 g and CBV below 1.3 ml/100 g while viable regions had CBF and CBV above those thresholds. One patient had CBV and CBF in the right middle cerebral territory above infarction thresholds at admission; however, at 5 days post all those regions became infarcted. CT angiography showed that right middle cerebral remained occluded at 24 hours and 5 days. Thus initially viable tissue may progress to infarction if the occlusion does not reopen.

CBV vs CBF for Tissue Classification



CONCLUSION

CBF and CBV maps derived from CTP allow definition of quantitative thresholds to separate viable ischemic tissue from infarcted tissue in acute stroke patients. Ischemic tissue will not remain viable if reperfusion does not occur early. CTA studies are critical to determine patency of affected arteries on follow-up CTP studies.

KEY WORDS: Acute stroke, CT perfusion, ischemic penumbra

The authors of this work have indicated the following affiliations/disclosures: General Electric Medical Systems: Licensing agreement for CT perfusion software.

Paper 16 Starting at 10:39 AM, Ending at 10:47 AM**Comparison of Perfusion CT and CT Angiography Source Images with Perfusion-Weighted and Diffusion-Weighted Imaging in Patients with Acute Stroke < 6 Hours**

Schramm, P.¹ • Schellinger, P. D.¹ • Klotz, E.² • Fiebach, J. B.¹ • Sartor, K.¹

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PURPOSE

While stroke MR imaging is the evolving diagnostic gold standard, many stroke patients are admitted to hospitals without 24/7 MR imaging availability. We aimed to determine the diagnostic accuracy of the combination of noncontrast-enhanced CT (NECT), CT angiography (CTA) including CTA source images (CTA-SI) and perfusion CT (PCT) in comparison with a multiparametric stroke MR protocol in acute stroke < 6 hours.

MATERIALS & METHODS

Noncontrast-enhanced CT, PCT, CTA, stroke MR imaging, including diffusion-weighted and perfusion-weighted imaging, and MR angiography (MRA) were performed in patients with symptoms of acute stroke < 6 hours. We analyzed infarct volumes on patients' arrival as shown on NECT, PCT, CTA-SI, diffusion-weighted and perfusion-weighted imaging (Wilcoxon, Spearman) and compared it to the final infarct lesion as shown on day 5 NECT.

RESULTS

Twenty-three stroke patients underwent CT and MR scanning within 6 hours. Neither did PCT TTP volumes differ from perfusion-weighted imaging TTP ($p = 0.586$), nor did PCT CBV differ from perfusion-weighted imaging CBV ($p = 0.642$). CTA-SI volumes did not differ from diffusion-weighted imaging volumes ($p = 0.272$). Lesion volumes measured in PCT Maps significantly correlated with lesion volumes on perfusion-weighted imaging ($p < 0.0001$ $r = 0.935$ for TTP; $p < 0.0001$ $r = 0.898$ for CBV). Also, highly significant correlation between PCT CBF lesion volumes and final infarct volume was found.

CONCLUSION

In hyperacute stroke, a multiparametric CT protocol allows a comprehensive diagnosis within less than 15 minutes by combining noncontrast-enhanced CT (NECT), perfusion CT (PCT), and CT angiography (CTA). When stroke MR imaging is not available, multiparametric stroke CT can give nearly equivalent information, and is significantly more comprehensive than NECT alone.

KEY WORDS: Acute stroke, perfusion CT, perfusion MR imaging

The authors of this work have indicated the following affiliation/disclosure: Siemens Medical Solutions CTCAP: Employee.

Paper 17 Starting at 10:47 AM, Ending at 10:55 AM**Assessment of Tissue Viability with Quantitative CT Perfusion in Acute Ischemic Stroke Patients Treated with Intraarterial Thrombolysis**

Schaefer, P. W. • Roccatagliata, L. • Ledezma, C. J. • Gonzalez, R. G. • Koroshetz, W. J. • Lev, M. H.

Massachusetts General Hospital
Boston, MA

PURPOSE

CT perfusion imaging reflects pathophysiologic changes during stroke evolution. We sought to determine parameters that distinguish brain regions destined to infarct from those that will survive despite hypoperfusion in patients treated with intraarterial (IA) thrombolysis.

MATERIALS & METHODS

CT perfusion images were obtained in 9 patients with proximal MCA emboli treated with IA thrombolysis within 6 hours. Cerebral blood volume (CBV) and CBF values were obtained in 1) infarct core with low CBV, low CBF and follow-up abnormality, 2) penumbra that infarcts with normal CBV, low CBF, and follow-up abnormality and 3) penumbra that remains viable with normal CBV, low CBF, and normal follow-up. Cerebral blood volume and CBF ratios were calculated. Cerebral blood flow values were also obtained in ROIs placed within gray matter (GM) or white matter (WM).

RESULTS

Mean CBF ratios for all tissue were 0.20, 0.31, and 0.43 for regions 1, 2, and 3, respectively and were significantly different. Mean CBF values for GM in regions 1, 2, and 3 were 13.2, 19.5, and 29.6 ml/100 gm/min, respectively and were significantly different. Mean CBF values for all tissue were 9.3, 19.0, and 21.1 ml/100 gm/min in regions 1, 2, and 3, respectively. Mean CBF values for WM were 4.49, 9.5, and 10.6 ml/100 gm/min in regions 1, 2, and 3 respectively. Mean CBV values for all tissue were 1.00, 2.3, and 2.4 ml/100 gm in regions 1, 2, and 3, respectively. Mean CBV ratios for all tissue were 1.00, 2.3, and 2.4 ml/100 gm in regions 1, 2, and 3, respectively. For all tissue CBF, WM CBF, all tissue CBV and CBV ratios, regions 2 and 3 were significantly different ($p < 0.05$) from region 1 but not from each other. All tissue with CBF < 12.9 ml/100 gm/min, CBF ratio < 0.32, CBF GM < 11.9 ml/100 gm/min, CBF WM < 3.1 ml/100 gm/min, CBV < 1.5 ml/100 gm and CBV ratio < 0.68 progressed to infarction. All tissue with CBF > 26.5 ml/100 gm/min, CBF ratio > 0.39, CBF GM > 32.4 ml/100 gm/min, and CBF WM > 18.4 ml/100 gm/min remained viable. Regions 2 and 3 had ROIs with CBV elevated above normal.

	Region 1	Region 2	Region 3	P value R2 vs R3
Mean CBF (ml/100 gm/min)	9.3	19.0	21.1	NS
Mean CBF Ratio	0.20	0.31	0.43	0.02
Mean CBF GM (ml/100 gm/min)	13.2	19.5	29.6	0.05
Mean CBF WM (ml/100 gm/min)	4.5	9.5	10.6	NS
Mean CBV (ml/100 gm)	1.0	2.3	2.4	NS
Mean CBV Ratio	0.49	0.82	0.91	NS

CONCLUSION

Mean CBF ratios and absolute CBF GM values are useful in distinguishing hypoperfused tissue likely to infarct from hypoperfused tissue likely to survive with IA thrombolysis. Other CBF and CBV values may provide adjunctive information. This information may be useful in differentiating patients likely to benefit from reperfusion therapy from those who are not.

KEY WORDS: CT perfusion, acute stroke

Paper 18 Starting at 10:55 AM, Ending at 11:03 AM

Are There Time-Dependent Differences of MR Imaging Parameters within 6 Hours after Stroke Onset?

Fiehler, J. • Kucinski, T. • Thomalla, G. • Weiller, C. • Rother, J. • Zeumer, H.

University of Hamburg
Hamburg, GERMANY

PURPOSE

Stroke heterogeneity in CT-based studies has been attributed as main cause for missing efficacy of intravenous rtPA therapy within 3 to 6 hours. The success of the PROACT II study within the 6-hours time window might be attributed at least in part to the design focused on the angiographically proven MCA occlusion. We investigated early time-dependent differences in acute stroke pathophysiology by multiparametric MR imaging.

MATERIALS & METHODS

Diffusion- and perfusion-weighted MR imaging and MR angiography of 112 acute ischemic stroke patients within < 6 hours after were dichotomized into a < 3-hour group (n = 52) and a 3-6-hour group (n = 60). Lesion volumes were determined for apparent diffusion coefficient (ADC_{man}) and the sub-region with ADC values < 550 × 10⁻⁹ mm² s⁻¹ (ADC < 550) and for the TTP delay of 2-4 s, 4-6 s, 6-8 s, and > 8 s. Mean values were computed for ADC and TTP delay within these volumes and in the mismatch (ADC_{man}-TTP > 2 s). To correct for the heterogeneity of occlusion types between both groups, an analysis of patients presenting with occlusion of the MCA_{trunk} (n = 36) and MCA_{branches} (n = 30) was performed.

RESULTS

ADC lesion volumes and TTP > 2 s lesion volume were not different in the < 3-hour group compared to 3-6-hour group. There was a greater ratio of ADC < 550 within the entire ADC lesion, most pronounced in patients with MCA trunk occlusions (32% vs 49%, p = 0.017). Patients with occlusion of the MCA_{trunk} in the < 3-hour group showed initially more severe neurologic symptoms and a larger mismatch volume (p = 0.047). The tissue volume with a TTP-delay of > 8 s was significantly smaller and the tissue volume with a TTP-delay of 2-4 s was significantly larger compared to the 3-6-hour group in patients with MCA_{branch} occlusions. This resulted in a less severe TTP delay in the mismatch region.

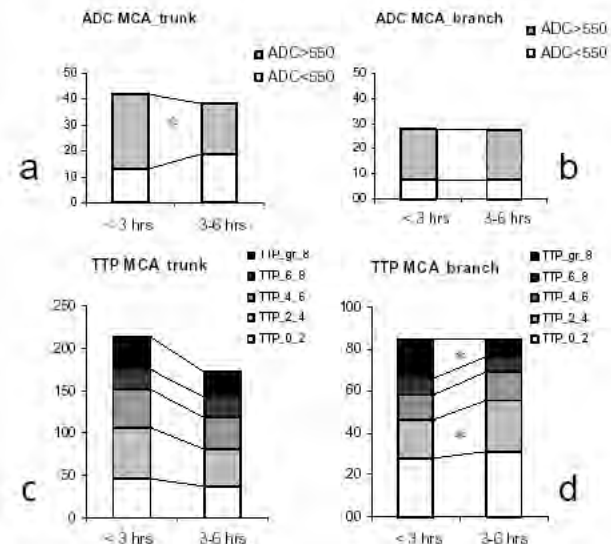


Figure: Diagrams for the lesion volumes of MCA_{trunk} and MCA_{branch}. Stacked bars for ADC show more severe ADC decreases (ADC < 550) than less severe (ADC > 550) after 3-6 hours of the in MCA_{trunk} (a) and no difference in MCA_{branch} (b). There was no significant difference in the composition of the perfusion abnormality in MCA_{trunk} (c). In MCA_{branch} there was smaller volume with severe TTP delay (> 8 s) after 3-6 hours.

CONCLUSION

The ADC values are lower after 3-6 hours within a stable lesion volume; lesions in perfusion-weighted imaging are either smaller or show a less severe deficit as compared to < 3 hours. These phenomena indicate that, with evolution of stroke, the “tissue at risk” and thus the salvageable tissue is shrinking both from the center (ADC) as well as from the periphery (perfusion-weighted imaging) of the lesion - this might explain the decreasing benefit of intravenous rtPA therapy. However, these time-dependent differences vary significantly between occlusion types and allow no exclusion from rtPA therapy based on a rigid 3-hour time window.

KEY WORDS: Stroke, diffusion, MR imaging

Paper 19 Starting at 11:03 AM, Ending at 11:11 AM

Early Metabolic Impairment in Relation to Vessel Occlusion Type in Stroke: Evaluation with Apparent Diffusion Coefficient Maps

Fiehler, J. • Kucinski, T. • Weiller, C. • Rother, J. • Zeumer, H.

University of Hamburg
Hamburg, GERMANY

PURPOSE

Primary source of tissue damage in ischemic stroke and primary target of thrombolysis is the occlusion of major cerebral arteries. Several studies using digital subtraction angiography described the relation of the type of vessel occlusion to recanalization rates in thrombolysis. Complementary to these studies, an assignment of the *initial metabolic impairment* to the site of vessel occlusion - with its specific recanalization results - would improve our understanding of stroke pathophysiology and might influence

recanalization strategies. The degree of the initially disturbed tissue metabolism in stroke can be estimated using the apparent diffusion coefficient (ADC).

MATERIALS & METHODS

Initial ADC lesions of 120 acute ischemic stroke patients within < 6 hours after stroke onset, on day 1 and on days 5-8 were investigated. These patients were categorized to pre-defined vessel occlusion sited using MR angiography. We used spatially normalized 3D maps of the ADC to assess the volume and distribution of the initial metabolic impairment. Lesion volumes of ADC were determined by manual delineation and by a threshold method for ADC values $< 550 \times 10^{-9} \text{ mm}^2/\text{s}$. Infarct volumes were analyzed on days 5-8 after stroke onset either on T2-weighted ($n = 109$) or CT images ($n = 11$). Three-dimensional probability maps of initial ADC lesions were used to visualize the anatomical distribution for each occlusion type. Vessel recanalization was analyzed from the follow-up MR study on day 1 on the basis of the perfusion-weighted and MR angiography studies.

RESULTS

Patients were categorized as follows: proximal ICA and MCA ($n = 19$), carotid-T ($n = 16$), combined ACA/MCA ($n = 4$), MCA_trunk ($n = 39$), MCA_trif ($n = 9$), MCA branch ($n = 33$). Mean lesion volumes in ADC550/ADCman/infarct were proximal ICA and MCA (18/45/88 mL), carotid-T (18/54/144 mL), combined ACA and MCA (14/59/121 mL), MCA_trunk (16/41/71 mL), MCA_trif (17/42/48), MCA_branch (7/27/29 mL). The highest rate of reperfusion was found after MCA_branch occlusion (64.3%) whereas lowest rate was seen in CTO and occlusion of ICA/MCA (7.7% and 38.5%).

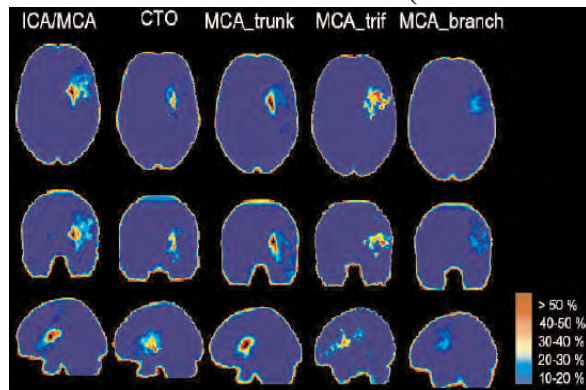


Figure: Spatial distribution of severe ADC decreases below a threshold of $550 \times 10^{-9} \text{ mm}^2/\text{s}^2$. Most severe ADC decreases were observed in the striatum, which is supplied predominantly by terminal branches, probably due to the rapid breakdown of tissue metabolism. Severe decreases also in white matter and cortical regions can be observed in occlusions of the ICA/MCA and MCA_trunk.

CONCLUSION

The early ischemic tissue impairment estimated by the ADC can be small even in patients with proximal vessel occlusions. In case of low recanalization rates, these small lesions are followed by large infarcts and a bad clinical outcome. This scenario suggests a considerable lesion growth over time, which might be averted by therapeutic vessel recanalization. The development of therapeutic interventions to improve the recanalization rates is mandatory in patients with proximal vessel occlusions.

KEY WORDS: Stroke, therapy, MR imaging

Paper 20 Starting at 11:11 AM, Ending at 11:19 AM

Asymmetric Oxygen-Related Cerebrospinal Fluid Hyperintensity on Fluid-Attenuated Inversion-Recovery Imaging in Patients with Focal Hemodynamic Abnormalities: A New Marker for Brain Tissue Oxygen Levels?

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PURPOSE

Cerebrospinal fluid (CSF) hyperintensity on fluid-attenuated inversion-recovery (FLAIR) imaging has been identified in patients breathing supplemental oxygen, and probably represents the effect of T1 shortening caused by increased CSF oxygenation (1, 2). Given the contiguity of CSF and the cerebral extracellular spaces, these changes may be sensitive to the oxygen level of surrounding brain tissue (3). Previous reports have demonstrated oxygen-related FLAIR hyperintensity in a bilateral, symmetric pattern. This report describes several patients with hemodynamic abnormalities demonstrating asymmetric FLAIR CSF hyperintensity in the setting of supplemental oxygen administration.

MATERIALS & METHODS

Eight patients with asymmetric FLAIR (TR/TE/TI = 11000/140/2800 ms) hyperintensity during or following supplemental oxygen were identified. A 66-year-old woman had a chronic subcortical right hemispheric infarction and right ICA stenosis; 6 patients were imaged after carotid artery stenting; 1 patient was imaged during intracarotid balloon test occlusion (BTO). The latter two groups were studied using an integrated angiography-MR suite, supported during or immediately prior to MR imaging with nasal or facemask oxygen.

RESULTS

In the chronic stroke patient, there was marked hyperintensity within the left hemispheric CSF spaces following oxygen; the right hemispheric CSF spaces were normal. One hour later, noncontrast CT demonstrated normal CSF signal bilaterally, excluding subarachnoid hemorrhage. Cerebral angiography later that day demonstrated thrombus near the takeoff of the right CCA and 80% right ICA stenosis. No crossfilling to the right during left ICA injection was seen; 50% stenosis of the left ICA was present. Of 8 carotid stent patients studied, 6 demonstrated unilateral hyperintensity in the convexity CSF after stenting in the territory of the stented artery. No pre-stent images with oxygen were performed; however, postcontrast FLAIR images were normal. In 1 of 2 patients imaged with oxygen during BTO, CSF hyperintensity was present over the convexities ipsilateral to the occlusion. In the stent and BTO patients, Gd-DTPA was administered several hours earlier; the possibility that the unilateral CSF hyperintensity reflects extravasated contrast cannot be excluded, but is considered unlikely.

of the parameters on PCT results is mostly unknown. The goal of this study was to assess the influence of the temporal sampling rate and the contrast bolus volume on PCT results.

MATERIALS & METHODS

Sixty consecutive patients, all with ischemic hemispheric stroke of 12-hours duration or longer, underwent PCT examinations that varied only in the volume of contrast material used for the bolus. The patients were divided into 4 groups of 15 patients based on the volume of contrast used for PCT 30 mL, 40 mL, 50 mL, and 60 mL. For each group of patients, regional cerebral blood volume (rCBV), flow (rCBF), mean transit time (MTT), and time-to-peak (TTP) maps were calculated using 7 different temporal sampling intervals: 0.5, 1, 2, 3, 4, 5 and 6 seconds. PCT results were compared using Wilcoxon (Mann-Whitney) tests, with a significance level set at 0.01 to account for the multiple testing. Signal-to-noise ratios, time duration of arterial entrance to venous exit, and radiation dose also were assessed for each bolus volume.

RESULTS

With increasing temporal sampling intervals, rCBV, rCBF, and TTP values were overestimated significantly, and MTT values significantly underestimated compared with the classical temporal sampling interval of 1 second. Maximal allowable sampling intervals to avoid overestimation of rCBV, rCBF, and TTP, and underestimation of MTT, were found as: 2, 3, 3, and 4 seconds for the 30 mL, 40 mL, 50 mL, and 60 mL bolus volumes, respectively. Venous exit of contrast was observed in 97.5% of patients after 36, 42, 42, and 48 seconds, respectively, for the four bolus volumes. On the other hand, there was no difference in signal-to-noise ratios for the four volumes. Finally, the brain effective radiation dose varied between 0.852 and 1.867 mSv, depending on the PCT protocol used; cine mode with two injections of 40 mL boluses and toggling-table technique with injection of one 60 mL bolus were associated with the lowest radiation doses.

CONCLUSION

A temporal sampling interval greater than 1 second can be used for PCT scanning, without altering the quantitative accuracy of PCT results. Increasing the sampling interval reduces the radiation dose to the patient and perhaps may allow for an increased spatial coverage.

KEY WORDS: Perfusion CT, acquisition technique, stroke

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of perfusion CT prototype software made by Philips Medical Systems for brain perfusion assessment.

The authors of this work have indicated the following affiliations/disclosures: Philips Medical Systems: Employee.

CONCLUSION

Asymmetric FLAIR CSF hyperintensity in the setting of supplemental oxygen was observed in several patients with underlying hemodynamic abnormalities and following neurointerventions. Quantitative CSF T1 measurements with and without oxygen may provide insight into cerebrovascular hemodynamics and local brain tissue oxygenation.

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KEY WORDS: FLAIR, oxygen, CSF

The authors of this work have indicated the following affiliations/disclosures: Philips Medical Systems: Employee.

Paper 21 Starting at 11:19 AM, Ending at 11:27 AM

Dynamic Perfusion CT: Optimizing the Temporal Resolution and Contrast Volume for Calculation of Perfusion CT Parameters in Stroke Patients

Wintermark, M.^{1,2} • Smith, W. S.² • Ko, N. U.² • Quist, M.³ • Schnyder, P.¹ • Dillon, W. P.²

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PURPOSE

Numerous parameters are involved in the acquisition of a dynamic perfusion CT (PCT) series. The relative influence

Paper 23 Starting at 11:35 AM, Ending at 11:43 AM**Assessment of Cerebral Hemodynamics and Vascular Reserve in Patients with Symptomatic Carotid Artery Occlusion or Critical Carotid Stenoses: An Integrated MR Method**

Griffiths, P. D.

University of Sheffield
Sheffield, UNITED KINGDOM

PURPOSE

We describe an MR-based methodology designed to study cerebral hemodynamic compromise in patients with symptomatic carotid occlusions and critical stenoses.

MATERIALS & METHODS

Twelve patients were studied, all with unilateral transient ischemic attacks ipsilateral to either an occluded carotid artery (8) or a stenosis of 95-99% severity (4). Imaging consisted of MR angiography of the cervical carotids and circle of Willis, MR imaging of the brain and dynamic gadolinium MR perfusion studies before and after the intravenous injection of acetazolamide (1000 mg). All examinations were performed on a 1.5 T superconducting system (Eclipse, Philips Medical Systems). The perfusion studies consisted of single-shot, gradient-recalled echo-planar technique (T2*-weighted). Those studies were analyzed using the proprietary software to calculate transit time (TTfm) and relative cerebral blood volume (rCBV); however only TTfm data are discussed in this paper. We have described previously the appropriateness of performing repeat perfusion studies at the same MR event (1).

RESULTS

All patients showed increased TTfm in the symptomatic hemisphere at rest. In the hemispheres over occluded vessels this ranges from 0.9s to 9.9s when compared to the opposite side and 1.8s to 3.8s over critically stenosed vessels. The asymmetries in TTfm became more pronounced after acetazolamide in all patients. There was an inverse correlation between the degree of increased TTfm and the degree of collateralization around the circle of Willis.

CONCLUSION

Assessment of cerebrovascular reserve using an acetazolamide challenge can be performed in one MR imaging event. The demonstration of both the macroscopic vascular anatomy and microvascular reserve in patients with possible low-flow states is important for full assessment.

REFERENCES

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KEY WORDS: Carotid stenosis

Monday Morning

10:15 AM - 11:45 AM

Room 606 - 609

**(6c) Head & Neck: General
(Scientific Papers 24 - 35)**

See also Parallel Sessions

*(6a) Adult Brain: General and High Field Imaging
(6b) Adult Brain: Cerebrovascular Disease and Stroke
(6d) Pediatrics: Fetal and Neonatal Imaging*

Moderators: Nancy J. Fischbein, MD
Patricia A. Hudgins, MD

Paper 24 Starting at 10:15 AM, Ending at 10:23 AM**MR Imaging of Fetal Head and Neck Masses**

Robson, C. D.¹ • Barnewolt, C. E.¹ • Rahbar, R.¹ • Ozgen, B.² • Levine, D.³ • Estroff, J.¹ • Fishman, S.¹ • Jennings, R.¹

¹Children's Hospital, Boston, MA, ²Brigham and Women's Hospital, Boston, MA, ³Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA

PURPOSE

Fetal head and neck masses commonly are encountered on routine prenatal sonography. Fetal MR imaging has emerged as a useful tool for further characterization of these masses. The purpose of this paper is to retrospectively evaluate MR images of 10 patients found to have fetal head or neck masses, and to evaluate the utility of MR imaging in providing accurate diagnoses and guiding further intervention.

MATERIALS & METHODS

The medical records and imaging studies of 10 women found to have fetal head or neck masses were reviewed. All patients were referred following the detection of a mass on sonography. All patients underwent MR imaging using a long extremity coil and single-shot fast spin-echo T2-weighted images. Maternal ages ranged from 20 to 39 years. The gestational age at the time of the MR imaging ranged from 24 to 35 weeks.

RESULTS

Fetal MR imaging demonstrated complex, partly cystic masses with an accurate diagnosis of teratoma in 4 fetuses. MR imaging demonstrated compression of the airway in these 4 patients, who subsequently were delivered with Caesarian section and the EXIT (ex-utero intrapartum treatment) procedure. All babies underwent surgical resection of tumor shortly after birth. Macrocytic lymphatic malformations were diagnosed accurately on MR imaging in 4 fetuses with multicystic masses, with a differential diagnosis of ter-

atoma in one case. Trisomy 21 was diagnosed on amniocentesis in one patient. Another fetus in a twin pregnancy suffered in utero demise with massive hydrops fetalis and was diagnosed with Turner syndrome on amniocentesis. Three babies were born, diagnosed with lymphatic malformation based clinical examination and postnatal imaging, and managed conservatively. One patient had a massive solid scalp mass, diagnosed initially as congenital hemangioma, or possibly other tumor. Subsequent MR images demonstrated a decrease in size of the mass consistent with hemangioma, with postnatal correlation. One patient had a small cystic mass adjacent to the nose on fetal imaging. Antenatally this was thought to be a cephalocele or dermoid cyst. Following birth the correct diagnosis of a supernumerary nostril was made.

CONCLUSION

Fetal head and neck masses are well characterized on MR imaging, which provides useful and sometimes diagnostic soft tissue characterization. Information about airway compression is essential for planning safe delivery. Figure 1 (a) SSFSE T2 weighted sagittal MR image reveals a heterogeneous mass protruding out of the mouth. A diagnosis of teratoma was made and confirmed following delivery with the EXIT procedure. (b) Sagittal SSFSE MR image reveals severe fetal hydrops (small arrow) in one fetus of a twin gestation. There is a higher signal intensity cystic appearing mass surrounding the neck consistent with lymphatic malformation. The brain is hypointense. Turner syndrome with fetal demise was diagnosed.

KEY WORDS: Fetus, tumor, malformation

Paper 25 Starting at 10:23 AM, Ending at 10:31 AM

Imaging of Foregut Duplication Cysts of the Neck and Tongue in Children

Ozgen, B.¹ • Robson, C. D.² • Rahbar, R.² • Nose, V.² • Sherman, D.³

¹Brigham and Women's Hospital, Boston, MA, ²Children's Hospital, Boston, MA, ³Albany Medical College, Albany, NY

PURPOSE

Foregut duplication cysts (FDC) are congenital anomalies that occasionally occur in the neck and tongue. In this location, they usually are misdiagnosed radiologically as dermoid cysts, thyroglossal duct cysts, or vascular malformations. We evaluated the clinical and imaging features of five cases of FDC occurring in the neck and tongue, in an effort to better define the imaging characteristics of these uncommon lesions.

MATERIALS & METHODS

The imaging studies (3 MR images and 2 CT) of five cases with the histopathologic diagnosis of FDC resected from the neck and tongue were reviewed retrospectively.

RESULTS

Five patients (4 boys and 1 girl) with ages ranging from 5 days to 6 years were evaluated. Two cases were asymptomatic, two had feeding problems and one had speech difficulty at the time of presentation due to the location of the lesion. The cysts were located at the anterior part of the tongue in 3 cases and along the anterior aspect of the neck in 2 cases (one overlying the left infrahyoid strap muscle and one immediately anterior to the trachea, between the thyroid gland and the thymus). All lesions were sharply margined, tubular or circumscribed in shape, with low attenuation on CT and isointense with CSF on MR imaging. Contrast was administered in all studies with no enhancement of any of the lesions.

Figure (a). Axial contrast-enhanced CT image reveals a unilocular hypodense, nonenhancing mass ventral to the trachea. (b). Sagittal fat-suppressed T2-weighted MR image in a 2nd patient reveals a serpiginous, midline mass within the tongue that is isointense with CSF.

CONCLUSION

Foregut duplications cysts occur rarely in the neck and tongue but should be considered in the differential diagnosis of cystic masses in infants and young children, especially for congenital midline cystic lesions of the anterior third of the tongue. It is particularly important to differentiate FDC from thyroglossal duct cysts, as the surgical treatment for these two entities differs.

KEY WORDS: Foregut duplication cysts, children, head and neck

Paper 26 Starting at 10:31 AM, Ending at 10:39 AM**Bulging Oval Window: HR CT and MR Imaging in the Diagnosis of Perilymphatic Hydrops**

Booth, T. N.^{1,2} • Brenski, A.^{1,2} • McClay, J.^{1,2} • Rollins, N. K.^{1,2} • Roland, P.^{1,2}

¹Children's Medical Center of Dallas, Dallas, TX,

²University of Texas Southwestern Medical Center, Dallas, TX

PURPOSE

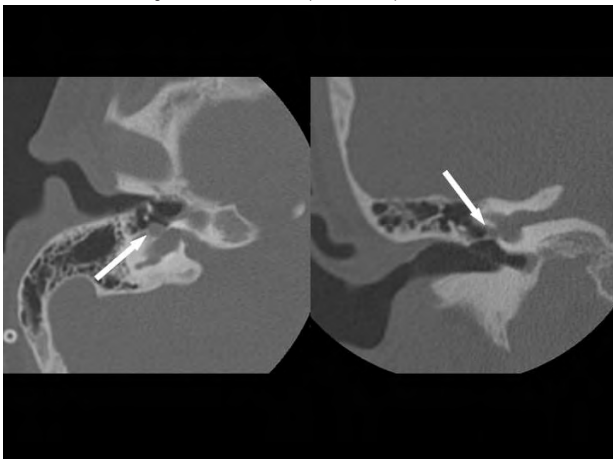
Perilymphatic hydrops is caused by abnormal communication between CSF and the perilymph of the inner ear. The resultant increase in pressure leads to displacement and or perforation of the stapes footplate. We report the clinical presentation and imaging findings in children with perilymphatic hydrops associated with inner ear anomalies. We will demonstrate the appearance of a bulging oval window, which commonly was found in our patients and has not been described in the literature.

MATERIALS & METHODS

All patients (n = 3) presented with SNHL. Only 2 patients had a history of recurrent meningitis. Ages - 5, 9, and 9 years. HR CT was performed in all patients using 1 mm collimation and targeted magnified reconstruction. Three-dimensional FSE T2-weighted MR imaging was obtained in 2 patients. All patients were evaluated by a pediatric otolaryngologist. Two of the patients have surgical confirmation.

RESULTS

Severe inner ear anomalies were present in all patients. The cochlea was absent in 5/6 ears and the vestibular system demonstrated severe dysplasia in 5/6 ears. The IAC was normal (n = 1), large (n = 2), and small (n = 3). An undulating contour to the bony margins of the IAC was present in 2 ears. One ear demonstrated a large facial nerve canal. A deficient lamina cribrosa was noted in 3/6 ears, although the structure was difficult to evaluate in patients with a small IAC. A bulging oval window was defined as fluid density or intensity material protruding from the vestibule through the oval window and was present in 5/6 ears (figure). HR CT and MR imaging both demonstrated the presence of a bulging oval window. The one ear that did not demonstrate this finding also had a nearly atretic IAC (1.2 mm).

**CONCLUSION**

Preoperative diagnosis of perilymphatic hydrops is important. Perforation of the stapes can be a source of recurrent meningitis especially in a child with SNHL. The presence of hydrops may lead to a stapes gusher during surgical manipulation and could affect the continuation of the surgical operation, cause further loss of hearing, as well as increase the risk of meningitis. We believe direct visualization of a bulging oval window is an additional finding that will be useful in the preoperative diagnosis of perilymphatic hydrops associated with inner ear anomalies. Findings such as an enlarged, undulating IAC and deficient lamina cribrosa were found less frequently in our group of patients. These abnormalities should be sought after in any patient presenting with SNHL and or recurrent meningitis.

REFERENCES

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KEY WORDS: Temporal bone, congenital, meningitis

Paper 27 Starting at 10:39 AM, Ending at 10:47 AM**High Resolution Volumetric CT of Temporal Bone Pathology Using Digital Flat-Panel Array Detector**

Gupta, R.^{1,2,3} • Bartling, S.⁴ • Caruso, P.² • Grasruck, M.³ • Stierstorfer, K.³ • Flohr, T.³ • Curtin, H.² • Brady, T.¹

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⁴Siemens Medical, Forchheim, GERMANY

PURPOSE

Volumetric CT (VCT) scanners offer very high resolution by virtue of a digital flat-panel array. We have shown that normal temporal bone anatomy is better visualized using a VCT scanner as compared with multidetector CT scanners (MDCT) (Gupta, et al., ASNR 2002 and RSNA 2003). The purpose of this study is to determine if VCT offers superior depiction of temporal bone abnormalities.

MATERIALS & METHODS

Fifteen temporal bone specimens, 9 abnormal and 6 normal, were scanned using VCT and MDCT scanners. The abnormal specimens included patients with acquired and congenital sensory neural hearing loss (n = 4), congenital type II collagen disorder (n = 2), otospongiosis (n = 2), and otospongiosis, status poststapedectomy and stapes prosthesis (n = 1). Two normal temporal bone specimens and two normal cadaveric head specimens (n = 4 ears) were scanned also. The VCT scanner consists of a 40 x 30 cm square digital flat panel detector mounted on a Sensation-16 (Siemens, Forchheim) gantry. The detector consists of a matrix of 2K x 1.5K detector elements, each at 200 micron-square. Five hundred eighty projections were acquired in a 360 deg rotation at 80 kV and 20 mA. A modified Feldkamp algorithm was used for cone beam reconstruction. A volumetric stack with an isometric voxel size of 250 micron-cube, was reconstructed from the projection data. The specimens were

scanned in the VCT scanner at moderate dose (50 mA, 120 Kv), and at low dose (20 mA and 120 kV). The samples also were scanned in VolumeZoom 4 and Sensation-16.

RESULTS

Image quality was better with VCT. There were multiple instances where dehiscence in the bony covering of the facial nerve was better visualized on VCT. There was better depiction of the interscalar septum of the cochlea of potential benefit for the assessment of congenital malformations. Reformats benefited from the isotropic resolution offered by VCT. For example, the assessment of the incudo-stapedial joint was accomplished better using oblique slices from the VCT data as compared with MDCT data. The integrity of the stapes wire prosthesis and its articulation with the incus and with the oval window was assessed better on VCT.

CONCLUSION

Volumetric CT offers high resolution and excellent depiction of temporal bone abnormalities at potentially lower radiation doses than MDCT.

KEY WORDS: Temporal bone, CT, detector

The authors of this work have indicated the following affiliations/disclosures: Siemens Medical Solutions: Consultant, employee.

Paper 28 Starting at 10:47 AM, Ending at 10:55 AM

High Field-Strength MR Imaging in Two Animal Models of Menerie's Disease: Findings and Insights into the Etiology of this Disorder

Jewells, V. L. • Marshall, A. F. • Lee, Y. Z. • Kranz, P. • Lin, W. • Hardy, S. M. • Skaggs, J. D. • Zdanski, C.

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PURPOSE

Meniere's disease (MD) is thought to be due to endolymphatic hydrops. No definitive imaging study for hydrops currently exists, and the diagnosis remains a mainly presumptive clinical one. The purposes of our study were: to determine if high field-strength MR imaging can be used to demonstrate MD in two different animal models, to correlate these MR findings with histology, and to try to glean insight into the etiology and development of this disease based on MR features.

MATERIALS & METHODS

Of 14 guinea pigs, seven underwent surgical ablation of the vestibular aqueduct, five underwent continuous infusion of vasopressin (VP) during separate periods of 7 and 14 days, and two were used as controls. MR imaging was obtained pre and 4 hours postcontrast on a 3 T unit with a surface coil. All animals were imaged prior to any intervention and those who had surgery were studied at 8 and 12 weeks. Those treated with VP were imaged prior to infusion periods, at 1 or 2 weeks after initiation of infusion of VP, and with a second infusion period and at 1 week after cessation of infusion. The size and enhancement patterns of the cochleae were evaluated subjectively and ROIs were used to measure the

signal changes in the scalae (media and vestibularis/tympani) and whole cochleae. All animals were sacrificed and the size and histology features of the cochleae assessed.

RESULTS

Surgically- and VP-treated animals showed an apparent increase in cochlear volume by MR imaging which was confirmed histologically. Statistically significant increases in scalar and whole cochlear contrast enhancement were seen at 1 and 2 weeks in VP treated animals. One week after cessation of VP infusion, four animals showed progressive cochlear enhancement, and in one animal the ROIs returned to baseline. In the surgically-treated animals, a statistically significant contrast enhancement was seen in scalae media measurements but not in whole cochlea, or scalae vestibularis/tympani measurements. Additionally, differences were found in the intensity of enhancement between the scala media (endolymph) and scala vestibularis (perilymph) in both groups.

CONCLUSION

Guinea pigs may be used successfully to study MD which may be induced by surgery or VP administration. Animals with VP-induced MD showed greater contrast enhancement. Both surgery and VP-induced MD show similar changes in cochlear chamber size at MR imaging. Asymmetrical enhancement in the cochlear compartments, and differences between the surgical and VP groups supports the hypothesis that intracochlear membrane ruptures are present in MD, and that aquaporin 2-channel water transit induced by VP results in MD/endolymphatic hydrops.

KEY WORDS: Meniere's, endolymphatic hydrops

Paper 29 Starting at 10:55 AM, Ending at 11:03 AM

Physiologic Enhancement of the Labyrinth Demonstrated on Delayed FLAIR Imaging

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PURPOSE

Hyperintense labyrinthine signal on FLAIR imaging can indicate inner ear pathology. We present several cases of bilateral labyrinth hyperintensity on FLAIR, each resulting from contrast injected several hours prior to imaging.

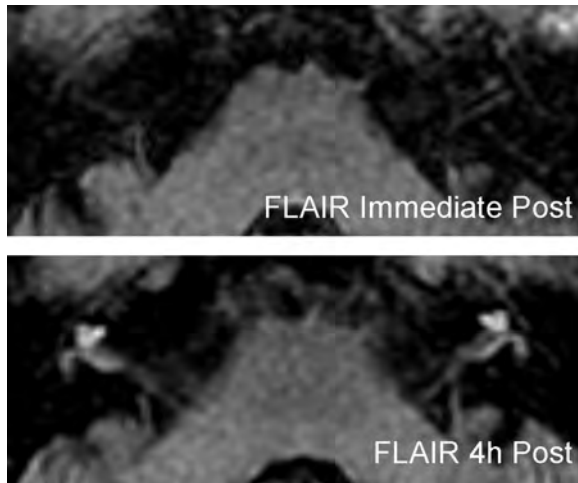
MATERIALS & METHODS

Routine 1.5 T brain MR images included immediate (within 15 minutes of injection) postcontrast FLAIR in patients from a variety of clinical protocols. Sequence parameters: TR 9000-11000, TE 135-145, ETL 22, BW 31 kHz, FOV 22 cm, matrix 256 x 192, thickness 5 mm, gap 0 mm, 2 acquisitions. Medical records were reviewed. The timing of brain MR imaging relative to other enhanced MR images was determined.

RESULTS

Seven examinations in four patients were identified with labyrinthine hyperintensity on FLAIR bilaterally. Each of these patients had a normal appearance of the labyrinth on at least one occasion within 6 months of the abnormal MR

imaging. No clinical evidence of inner ear pathology was present. Creatinine was normal (< 1.5) for 5 of the 6 abnormal exams. In one case, creatinine was 5.1. Review of the medical record revealed that contrast enhanced MR imaging (cardiac or abdominal) had been performed within 12 hours in all cases. In one case, brain MR imaging and cardiac MR imaging were performed on the same day on five separate occasions. On visits 1, 3, and 5, cardiac MR imaging preceded brain MR imaging by 3-5 hours, and on visits 2 and 4, brain MR imaging preceded cardiac MR imaging. Hyperintensity in the cochlea was observed only on the three occasions where the brain MR imaging followed the cardiac MR imaging. T1-weighted images did not demonstrate hyperintensity within the labyrinth. Hyperintensity in the anterior chamber of the globe also could be observed in delayed FLAIR images and was not observed on immediate FLAIR images.



CONCLUSION

Labyrinthine signal is normally completely suppressed on FLAIR. Altering the T1 of endolymph or perilymph changes the inversion time of inner ear fluid, resulting in marked hyperintensity as seen on T2-weighted images. Such alterations may occur with Gd enhancement from inflammation or neoplasm. Contrast-enhanced FLAIR is much more sensitive to this contrast entry than is T1-weighted imaging (1). In each of these cases, FLAIR signal abnormality was present in the absence of inner ear symptoms. Artefactual failure of FLAIR suppression (e.g., from inadequate inversion thickness) was excluded. Identification of contrast injections preceding the brain MR imaging by several hours explains the labyrinthine signal on "delayed" FLAIR. In animals, enhancement of the cochlea develops slowly following iv injection of Gd-DTPA, continuing to increase even 90 minutes following injection (2). This provides a physiologic explanation for the labyrinthine hyperintensity on delayed FLAIR. Further investigation of this phenomenon should provide insights into labyrinthine fluid homeostasis in normal and pathophysiologic states.

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KEY WORDS: Cochlea, hearing, perfusion

Paper 30 Starting at 11:03 AM, Ending at 11:11 AM

CT Characterization of Cochlear Dysplasia: Does Dilation at the Junction of the First and Second Turn Correlate with Sensorineural Hearing Loss?

Caruso, P.¹ • Numa, W.² • Merchant, S.¹ • Curtin, H.¹

¹Massachusetts Eye and Ear Infirmary, Boston, MA, ²Tufts-New England Medical Center, Boston, MA

PURPOSE

The rate of detection of inner ear dysplasia on HRCT in patients with sensorineural hearing loss (SNHL) has been estimated between 28-31% (1, 2). The diagnostic yield of HRCT for cochlear dysplasia has been estimated at between 5-12% (3, 4). Multidetector scanners allow for fine collimation and high quality reformatted images of the temporal bone, not previously available. Histopathologic studies of human temporal bones suggest that in minor cochlear dysplasia there is dilation of the cochlea beginning at the junction of the first and second turns (5). The purpose of our study is to measure the junction of the first and second turns of the cochlea using multidetector CT in normal patients, to determine how the normal measurement differs from that of patients with cochlear dysplasias, and to determine if the use of this normal measurement may be used to exclude cochlear dysplasias.

MATERIALS & METHODS

Temporal Bone CT scans were examined retrospectively in patients with congenital SNHL as well as in a group of normal controls. Images were evaluated by multiplanar reconstructions in the oblique axial, Pöschl, and Stenvers projections. The diameter of the cochlear lumen at the junction of the first and second turns (CDj12) was measured in a standardized fashion. Normal control values were compared with measurements obtained from scans of patients with congenital SNHL and cochlear dysplasias.

RESULTS

Measurement of the CDj12 in normal patients yielded a constant value that was independent of age. The CDj12 in patients with congenital SNHL and cochlear dysplasia measured consistently higher than that of normal controls.

CONCLUSION

Measurement of the CDj12 in normal patients yields a regular value that may serve to detect or to exclude cochlear dysplasia in patients with congenital sensorineural hearing loss.

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KEY WORDS: Cochlea, dysplasia, hearing

Paper 31 Starting at 11:11 AM, Ending at 11:19 AM

Cochlear Implant Candidate: Correlation between Age and Presence of Inner Ear Anomalies on High Resolution MR Imaging at 3 T and 1.5 T

Lane, J. I. • Witte, R. • Driscoll, C.

Mayo Clinic
Rochester, MN

PURPOSE

The association of anomalies of the inner ear with congenital or childhood onset sensorineural hearing loss (SNL) has been well established in the literature. We retrospectively reviewed high resolution MR studies in 66 cochlear implant candidates from 8/00 to 12/03 to determine the incidence of anomalies in both the pediatric and adult population.

MATERIALS & METHODS

All patients who are evaluated for profound SNL at our Cochlear Implant Clinic and found to qualify clinically for the procedure undergo high resolution MR imaging at 3 T or 1.5 T utilizing phased-array surface coils. Protocol included 3D FSE T2 or 3D CISS sequences acquired in the axial and oblique sagittal planes. All imaging studies were reviewed retrospectively by 2 neuroradiologists. Anomalies were classified broadly as to location (cochlea, endolymphatic duct/sac, vestibule, and IAC/cochlear nerve). Study population was split into those patients with onset of profound SNL before and after the age of 18 years. The incidence of anomalies in both groups was calculated.

RESULTS

Inner ear anomalies were found in 8 of 25 pediatric patients (31%) and in 8 of 41 adult patients (20%). Anomalies in adults consisted mainly of cases of dilatation of vestibular aqueduct/sac and modiolar deficiencies. Severe cochleovestibular anomalies were seen only in the pediatric age group.

CONCLUSION

Although the incidence of inner ear anomalies was greater in the pediatric age group, the presence of these anomalies was not insignificant in the adult group. Onset of profound bilateral SNL in an adult does not preclude the presence of congenital anomalies of the inner ear.

KEY WORDS: Inner ear anomalies, cochlear implant, high-resolution MR imaging

Paper 32 Starting at 11:19 AM, Ending at 11:27 AM

Correlation between Initial and Early Follow-Up CT Perfusion Parameters with Endoscopic Tumor Response in Patients with Advanced Squamous Cell Carcinomas of Oral Cavity/Oropharynx Treated with Organ Preservation Therapy

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²University of Michigan Hospitals, Farmington Hills, MI

PURPOSE

Current organ preservation regimens for oral cavity/oropharyngeal cancer are limited by the requirement of repeated endoscopic procedures under general anesthesia to evaluate the tumor volume and treatment response. The purpose of our study was to prospectively assess if pretherapy and early follow-up CT perfusion measurements correlate with response to induction chemotherapy and could be used as surrogate markers for tumor response.

MATERIALS & METHODS

Nine patients with advanced (Stage III, IV) squamous cell carcinoma of the oral cavity or oropharynx were enrolled in a prospective trial in which response to neoadjuvant chemotherapy was assessed. Patients underwent direct laryngoscopy and CT perfusion prior to treatment and after one cycle of neoadjuvant chemotherapy. The outcome variables were the surgeon's estimate of tumor volume during endoscopy with biopsy under anesthesia and values of CT perfusion parameters (capillary permeability, blood volume, blood flow, and mean transit time). Wilcoxon rank sum analysis was used to correlate the baseline values of blood flow and blood volume with response to induction chemotherapy. Comparison of agreement between the reduction in tumor volume and change in CT perfusion parameters was performed using Kappa estimate.

RESULTS

Baseline (pretherapy) values of blood volume showed significant correlation with endoscopic tumor response ($p < 0.05$). Reduction in the blood volume (by 20% or more) on follow-up studies also showed substantial agreement with clinical response as assessed with endoscopy (Kappa = 0.73). The agreement between change in blood flow, capillary permeability, and mean transit time and clinical response was fair (Kappa = 0.37).

CONCLUSION

These preliminary results show that deconvolution-based CT perfusion technique offers potential for noninvasive monitoring of response to induction chemotherapy in patients with oral cavity/oropharyngeal cancers. Pretherapy blood volume measurements and percentage reduction of blood volume on early follow-up studies are correlated significantly to endoscopic response to induction chemotherapy.

KEY WORDS: CT perfusion, squamous cell cancer, oral cavity

Paper 33 Starting at 11:27 AM, Ending at 11:32 AM
Uncommon CT Findings in Relapsing Polychondritis

Branstetter, B. F.

University of Pittsburgh
 Pittsburgh, PA

PURPOSE

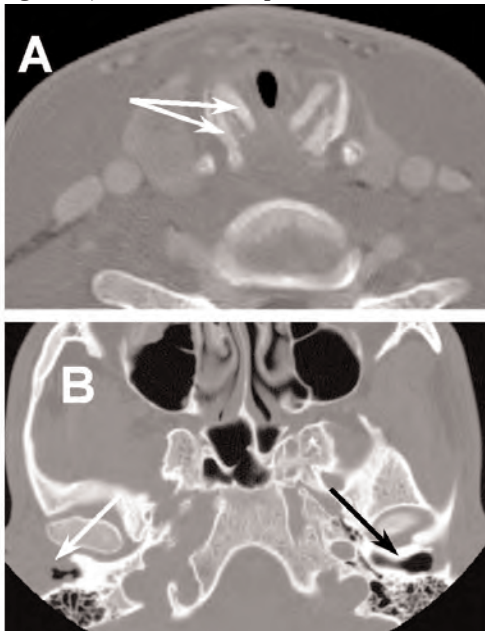
Relapsing polychondritis is a rare autoimmune disorder in which the autoantibodies target cartilage. Clinical findings may appear at any age. The bridge of the nose, the pinnae of the ears, and the laryngobronchial tree commonly are affected. In unusual cases, inflammation of other cartilages will precede the involvement of the nose and the pinna, producing a diagnostic dilemma for clinicians. There are several subtle radiologic findings that can suggest this rare entity.

MATERIALS & METHODS

A previously healthy 20-year-old male presented with a 3-month history of "recurrent anaphylactic episodes," the most recent of which required intubation. He had a long-standing history of "multiple external ear infections." No abnormalities of the nose or pinna were evident. CTs of the neck, chest, and paranasal sinuses were performed. The diagnosis of relapsing polychondritis was suggested on the basis of radiographic findings and confirmed with biopsy. The patient responded well to steroid therapy.

RESULTS

Neck CT revealed near-complete calcification of the laryngeal cartilages, unusual in a 20-year-old. There were areas of marked cricoid cartilage thickening with a symmetric train-track calcification pattern (Figure A). Other portions of the laryngeal cartilages showed marked thinning. The subglottic trachea was markedly narrowed, with thickening of the walls. On thoracic CT, scattered calcifications were seen throughout the walls of the tracheobronchial tree. The left lower lobe was collapsed completely, with narrowing of the central bronchi. CT of the paranasal sinuses revealed thickening of the cartilaginous walls of the external auditory canals, with complete sparing of the bony portions of the walls (Figure B). The nose and pinna were normal.



CONCLUSION

Unusual radiologic findings of relapsing polychondritis can precede the characteristic radiologic and clinical manifestations. Knowledge of these subtle early findings may allow the radiologist to diagnose relapsing polychondritis and help avoid disease complications.

KEY WORDS: Relapsing polychondritis, polychondritis

Paper 34 Starting at 11:32 AM, Ending at 11:37 AM

Cricoarytenoid Rheumatoid Arthritis: An Important Consideration in Aggressive Laryngeal Lesions

Chen, J. J. • Myers, E. N. • Branstetter, B. F.

University of Pittsburgh
 Pittsburgh, PA

PURPOSE

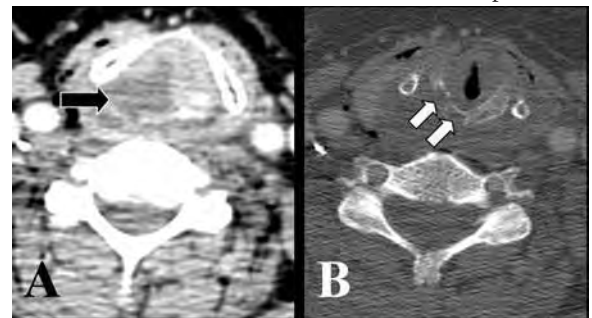
The most frequent cause of an aggressive laryngeal mass is squamous cell carcinoma (SCC). Rheumatoid arthritis is known to affect the larynx, but usually does not produce an aggressive mass.

MATERIALS & METHODS

We present a case of a 63-year-old female with rheumatoid arthritis, presenting with acute airway obstruction. Computed tomography (CT) was obtained and interpreted as SCC. With the presumed diagnosis of SCC, the patient underwent surgical biopsies which revealed rheumatoid arthritis of the cricoarytenoid joint. The patient was discharged on an increased dose of antiinflammatory medications. On follow-up visits, the patient was doing well with no clinical evidence of laryngeal mass.

RESULTS

On CT, an erosive mass on the right cricoid cartilage with significant destruction of the surrounding structures was presumed to represent SCC (Figure). The results of the laryngoscopy, in particular the submucosal nature of the lesion, were not available at the time of initial CT interpretation.



CONCLUSION

Laryngoscopy is used to differentiate SCC from rheumatoid arthritis. In addition to showing the distinctive features of rheumatoid arthritis at the cricoarytenoid joint, laryngoscopy is used to distinguish between mucosal and submucosal lesions. Submucosal lesions are much less likely to be SCC. When a submucosal lesion is observed, CT is employed to analyze the mass and define its extent. Malignant tumors of the larynx are invasive masses, often with central necrosis. Cartilage erosion on CT strongly suggests the presence of tumor. Unfortunately, these CT findings are not specific for

SCC. When a patient with a history of rheumatoid arthritis presents with a submucosal laryngeal mass, cricoarytenoid rheumatoid arthritis should be considered. Communication with the referring physician is important to obtain a complete history and to make the radiologist aware of the mucosal or submucosal nature of the pathology. Failure to diagnose rheumatoid arthritis of the larynx may subject the patient to unnecessary surgery and anxiety about a potentially lethal disease.

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KEY WORDS: Rheumatoid arthritis, larynx, cricoarytenoid joints

Paper 35 Starting at 11:37 AM, Ending at 11:42 AM

Anomalous Course of Carotid Artery through Middle Ear Detected by CT Angiography

Teng, M. M. H.

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Taipei, TAIWAN REPUBLIC OF CHINA

PURPOSE

To show the value of CT angiography in demonstrating the anomalous course of internal carotid artery through middle ear cavity and sphenoid sinus.

MATERIALS & METHODS

There has been some difficulty in removal of bony structures while preserving arteries passing through the skull base on CT angiography. Demonstration of the whole course of arteries in the head and neck similar to digital subtraction angiogram remains a difficult task. For this reason, CT angiography has been less popular than conventional X-ray angiography, or MR angiography for head and neck region. We encountered two patients with anomalous course of the internal carotid artery. In one case the carotid artery passes through the middle ear cavity, and in the other it passes through the sphenoid sinus.

RESULTS

These anomalous courses of the internal carotid artery were both demonstrated on CT angiography. They were not detected on previous MR angiography or conventional X-ray angiography.

CONCLUSION

Demonstration of bony structure and artery in the skull base on CT angiography facilitate the detection of anomalous course of the carotid artery.

KEY WORDS: Anomalous course of carotid artery, CT angiography

Monday Morning

10:15 AM - 11:45 AM

Room 611 - 612

(6d) Pediatrics: Fetal and Neonatal Imaging (Scientific Papers 36 - 46)

See also Parallel Sessions

(6a) *Adult Brain: General and High Field Imaging*

(6b) *Adult Brain: Cerebrovascular Disease and Stroke*

(6c) *Head & Neck: General*

Moderator: Vincent P. Mathews, MD
Charles L. Truwit, MD

Paper 36 Starting at 10:15 AM, Ending at 10:23 AM

Fetal MR Imaging in the Detection of Malformations of Cortical Development

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University of California San Francisco
San Francisco, CA

PURPOSE

To determine if malformations of cortical development can be detected better on fetal MR imaging as compared with prenatal ultrasound.

MATERIALS & METHODS

We searched our imaging data base for cases of cortical malformations on fetal MR imaging. Referring indications for fetal MR imaging were either small head size or other suspected major brain abnormalities on prenatal ultrasound. We excluded cases of periventricular heterotopia in the absence of other cortical malformations. Fetal MR images were reviewed by two pediatric neuroradiologists. An ultrasonographer and neuroradiologist reviewed prenatal ultrasound images.

RESULTS

There were six cases of cortical malformations. Gestational age at the time of MR imaging was 19 weeks to 34 weeks. The six cases included: diffuse cortical dysgenesis (N = 3) associated with specific syndromes (Walker-Warburg, Aicardi, classical lissencephaly), schizencephaly (N = 2) (one with bilateral open lip schizencephalies, and another with open and closed lip schizencephalies and diffusely abnormal gyral pattern), and unilateral polymicrogyria (N = 1). In all six cases, the cortical malformations were sonographically occult. In 3 cases, other fetal brain abnormalities (agenesis of the corpus callosum, abnormal cerebellum and

brainstem, and irregularity of the ventricular margin) identified with sonography, prompted the MR imaging. In the fourth case, holoprosencephaly was suspected on the basis of the sonogram but fetal MR imaging demonstrated bilateral open lip schizencephalies, not holoprosencephaly. In two patients, referred for fetal MR imaging due to decreased head size, MR imaging identified classical lissencephaly in one and polymicrogyria in the other. Fetal MR findings were confirmed on postnatal MR imaging in two cases and neuropathologic examination in one.

CONCLUSION

Fetal MR imaging can detect malformations of cortical development, such as schizencephaly, polymicrogyria, focal and diffuse abnormal gyral patterns, and lissencephaly, as early as 19 weeks gestation. This subset of fetal brain malformations can be sonographically occult. The identification of cortical malformations on fetal MR imaging has significant prognostic implications since they can be associated with developmental delay, cognitive impairment, cerebral palsy, and epilepsy.

KEY WORDS: Fetal MR imaging, cortical malformation, developmental malformation

Paper 37 Starting at 10:23 AM, Ending at 10:31 AM

Fetal Brain MR Imaging in Placental Impairment

Prayer, D. • Brugger, P. C. • Mittermayer, C. • Chalubinski, K. • Kasprian, G. • Blacher, W.

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Vienna, AUSTRIA

PURPOSE

A functional feto-placental unit is essential for adequate blood supply to the fetal brain. Impaired placental function may interfere with normal fetal brain development (1). This may be the case in premature rupture of membranes (PROM), infections, placental abruption, and may be associated with pathologic umbilical artery Doppler, eclampsia, intrauterine growth restriction (IUGR), and feto-fetal transfusion syndrome (FFTS). Aim of this study was to evaluate whether fetal MR imaging may detect pathologic changes in the brain in these situations.

MATERIALS & METHODS

Fifty-one pregnant women underwent 1-4 MR examinations between the 18th and 39th gestational week, because of PROM (21), history of infection (2), pathologic umbilical Doppler values (17), eclampsia (1), IUGR (5), FFTS (3), and placental abruption (2). MR imaging was done with a 1.5 T superconducting unit (Philips), using ultrafast T2-weighted, T1-weighted GRE-, FLAIR, diffusion-weighted, and advanced gradient-echo sequences in all orthogonal section planes with a slice thickness of 3-5 mm. In addition to the fetal central nervous system the placenta and the umbilical cord were assessed too.

RESULTS

Cerebral lesions/delay of brain development were diagnosed in 19 cases (4 PROM/6 pathologic Doppler/1 infection/3 FFTS). Hemorrhages appeared in 5, ischemic lesions in 8, with 3 only visualized on diffusion-weighted images, and 5 also or only on T2-weighted sequences. Retarded brain-mat-

uration (delayed myelination/gyration or small brain size) occurred in 6. Postnatal/postmortal workup is to date available in 16/51 cases. Eleven of 56 fetuses died. Placental abnormalities (defined as deviations from the normal age-related patterns that had been established on a sample of 110 normals), consisting of hemorrhages or premature degenerative changes (mainly infarctions) were found in 43, and pathologic appearance of the umbilical cord was seen in 3.

CONCLUSION

Impaired placental function may lead to changes that can be visualized by MR imaging (84% in our series). Cerebral compromise may be the consequence, as seen in 37% of our cases, that showed lesions or retarded cerebral development. The combination of conventional fetal MR imaging sequences with diffusion-weighted imaging enhances the sensitivity to detect cerebral lesions. Even if it is not yet clear which and what extent of pathologic placental changes might have an impact on fetal brain development (2), the assessment of the placenta and umbilical cord should be included in the evaluation of MR imaging of fetuses with suspect acquired brain pathology.

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KEY WORDS: Fetal MR imaging, placenta, diffusion-weighted imaging

Paper 38 Starting at 10:31 AM, Ending at 10:39 AM

In Utero MR Spectroscopy of the Human Fetal Brain

Girard, N. J.^{1,2} • Confort-Gouny, S.¹ • Viola, A.¹ • Viout, P.¹ • Chaumoitre, K.¹ • Fur, Y.¹ • Ranjeva, J. P.¹ • Cozzzone, P.¹

¹Hopital Nord, Université de la Méditerranée, Marseille, FRANCE, ²UMR-CNRS 6612, Faculté de Médecine, Marseille, FRANCE

PURPOSE

To demonstrate the efficiency of H MR spectroscopy (MRS) of the human fetal brain.

MATERIALS & METHODS

Spectra were acquired on a 1.5 T MR device (Symphony Maestro) with PRESS sequences including short and long echo-time (TR of 1500 ms, TE of 30 and 135 ms). The volume of interest (VOI) was of 20 x 15 x 15 (4.5 ml) and located within the cerebral hemisphere (at the level of the centrum semi ovale whenever possible). Eighty patients have been examined, MRS being performed in the same session of the standard fetal brain MR imaging. The gestational age (GA) ranged from 27 to 39 weeks including normal (n = 50) and pathologic brains (n = 30). Normative metabolic values were obtained in cases with normal standard MR images and/or normal neurologic outcome at 6 months of age. Abnormal MR imaging included malformations, destructive lesion, isolated ventricular dilatation, pregnancy at risk of brain damage (i.e., twin-to-twin transfusion syndrome). The concentration of cerebral metabolites was obtained by a method of relative quantification; each metabolite concentration being represented by its area divided by the sum of

the areas of all other metabolites. The cerebral metabolites taken into account were myoinositol (Ins), choline (Cho), creatine (Cr), glutamate-glutamine (Glx), aspartate (Asp), n-acetylaspartate (NAA). The results were expressed also as a ratio of areas of metabolites.

RESULTS

There is a significant increase of NAA, decrease of Ins in the normal brain with increasing GA. A tendency in increase of Glx and in decrease in Cho was seen also with increasing GA. Analysis of the pathologic brains showed no specific metabolic pattern in the different groups of pathology. However some characterization was possible: increased level of Cr was seen in hypoxic cases, suggesting white matter gliosis. A case of mild ventriculomegaly with ependymal cysts showed very low level of Cr and NAA of unknown origin. Cases of mild ventriculomegaly showed spectra similar to normal controls at the same gestational age, suggesting an underlying normal brain associated to the ventricular dilatation.

CONCLUSION

Fetal brain MRS is becoming a tool in the evaluation of the brain maturation and development. The definition of normal spectra at different gestational ages is necessary in order to characterize brain abnormalities especially when subtle changes are seen on conventional MR sequences (i.e., isolated ventriculomegaly, twin-to-twin transfusion syndrome, and infections).

KEY WORDS: MR spectroscopy, fetal brain

Paper 39 Starting at 10:39 AM, Ending at 10:47 AM

MR Imaging of the Fetal Cerebellar Vermis In Utero: Criteria for Abnormal Development, with Ultrasonographic and Clinicopathologic Correlation

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¹Hospital for Sick Children, Toronto, ON, CANADA,

²Mount Sinai Hospital, Toronto, ON, CANADA

PURPOSE

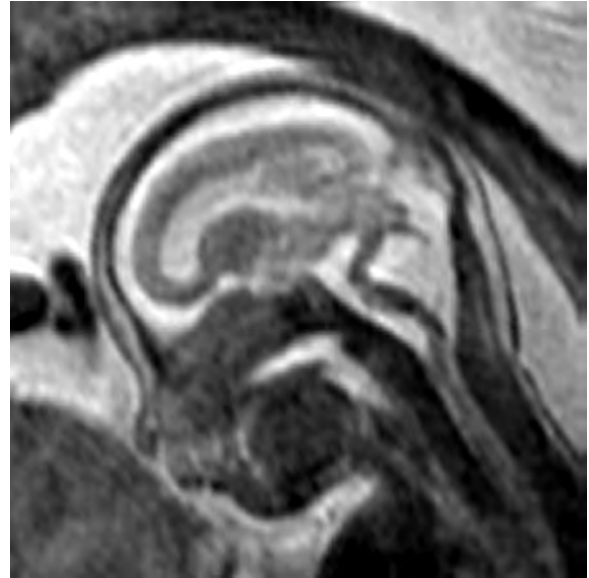
Our previous study produced an atlas of easily identifiable and reproducible measurements and markers of *normal* anatomical development of the fetal cerebellar vermis in vivo from 17.5 weeks gestational age to term. This study is to demonstrate easily identifiable and reproducible measurements and markers of *abnormal* development, with ultrasonographic and clinicopathologic correlation where available. Virtually all previous studies of development of the cerebellum have been performed on fetal specimens, and few in vivo studies discuss development of the cerebellar vermis per se.

MATERIALS & METHODS

Retrospective analysis of the midline sagittal views of the cerebellar vermis was performed in over 130 consecutive fetal MR examinations performed for CNS and non-CNS indications. Analysis included identification of the fastigial point and vermian fissures, degree of coverage of the fourth ventricle, cerebellar growth and proportions, tegmento-vermian angle, and associated abnormalities of the posterior fossa, brainstem and CNS.

RESULTS

Gestational age ranged from 14.9 to 38.6 weeks with a mean of 26.6 weeks. Useful midline sagittal views were obtained in over 100 studies. Approximately one quarter of these had abnormalities affecting the posterior fossa. These included fetuses with classic Dandy-Walker malformations and others within the Dandy-Walker spectrum which we subdivided according to presence of dysplasia or hypoplasia, abnormal tegmento-vermian angle, size of cisterna magna, and associated CNS abnormalities. Correlation with coronal and axial MR images and ultrasonographic images is demonstrated in addition to clinicopathologic and genetic diagnoses where available, however the final numbers are few.



CONCLUSION

We demonstrate MR imaging appearances of the normal and abnormal cerebellar vermis and posterior fossa with ultrasonographic and clinicopathologic correlation.

Part 2 of 2. See abstract 852 for part 1.

KEY WORDS: Vermis, fetal MR, Dandy-Walker

Paper 40 Starting at 10:47 AM, Ending at 10:55 AM

Early Laminar Organization of the Human Cerebrum Demonstrated by Automatic Segmentation of Diffusion Tensor MR Images in Extremely Premature Infants

Mukherjee, P. • Maas, L. C. • Carballido-Gamio, J. • Veeraraghavan, S. • Miller, S. P. • Partridge, S. C. • Henry, R. G. • Barkovich, A. J. • Vigneron, D. B.

University of California San Francisco
San Francisco, CA

PURPOSE

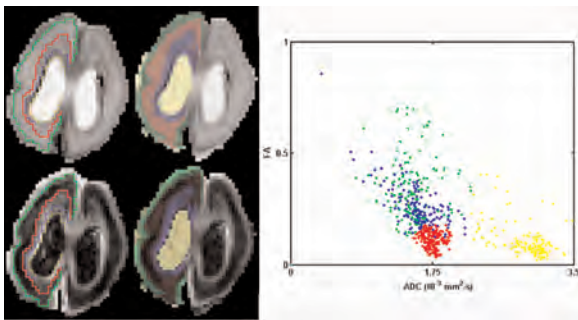
Diffusion tensor imaging (DTI) has been used to reveal the transient early laminar architecture of the developing fetal mouse brain ex vivo (1), many features of which are not apparent on conventional MR imaging. We present herein an automatic segmentation technique applied to DTI to delineate the early cerebral laminar organization of premature human newborns in vivo.

MATERIALS & METHODS

Two extremely premature infants were imaged at 25 and 27 weeks gestation with a high sensitivity neonatal head coil incorporated into an MR-compatible incubator. Diffusion tensor imaging was acquired with a multirepetition, single-shot echoplanar sequence. The apparent diffusion coefficient (ADC) and fractional anisotropy (FA) were calculated. Based on the pattern of ADC and FA values observed at the different cerebral lamina, manual segmentation was performed, and an automatic segmentation technique based on fuzzy logic was developed. First, ADC values were clustered into low, medium, and high ADC groups using fuzzy c-means clustering: CSF (high ADC), subplate (medium ADC), deep-to-subplate and cortical layers (low ADC). Cerebral spinal fluid pixels were removed for subsequent segmentation, and remaining pixels were clustered according to their FA values into subplate (low FA), deep-to-subplate and cortical layers (medium FA), and noise (high FA). Then a Mamdani-type fuzzy inference system was built to segment the subplate. Each input was fuzzified by two Gaussian membership functions which were created based on the means and standard deviations of the low and medium ADC and FA groups, and the segmentation was accomplished with the following two rules: 1. If the ADC is medium and the FA is low, then the pixel is subplate. 2. If the ADC is low and the FA is medium, then the pixel is nonsubplate. Nonsubplate pixels then were segmented based on their position relative to the subplate into cortical and deep-to-subplate layers.

RESULTS

The automatic segmentation was comparable to manual segmentation for both subjects. Figure 1 shows the manual (left) and automatic (right) segmentation results for the right cerebral hemisphere of the 25-week newborn, applied to ADC (top row) and FA (bottom row). ADC vs FA pixel values in the images of Figure 1, with pixel classification by automatic segmentation, is shown in Figure 2: high ADC for CSF (yellow); medium ADC and low FA for subplate (red); low ADC and medium FA for the cortical (green) and deep-to-subplate layers (blue).



CONCLUSION

We have developed an automatic segmentation technique based on fuzzy logic to delineate the early laminar organization of the premature human brain depicted by DTI. Automatic segmentation of the different lamina of the developing human cerebrum will enable volumetric studies to better understand and characterize normal and abnormal maturation during early human brain development.

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KEY WORDS: Diffusion, development, maturation

Paper 41 Starting at 10:55 AM, Ending at 11:03 AM

Microstructural vs Macrostructural Features of Cortical Development in Premature Newborns: Comparison of Diffusion Tensor Imaging with Cortical Gyration

deIpoli, A. • Mukherjee, P. • Henry, R. G. • Partridge, S. C. • Jin, H. • Lu, Y. • Miller, S. P. • Vigneron, D. B. • Barkovich, A. J.

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PURPOSE

Traditionally, imaging of human cortical development has been limited to the assessment of macrostructural gyration and sulcation. Recent studies suggest that diffusion tensor imaging (DTI) can characterize cortical maturation at the microstructural level (1-3). We examined the relationship between gyration and DTI in the developing peri-rolandic cortex of preterm infants. We hypothesized that DTI provides microstructural information about cortical development independent of macrostructural gyration, and that, therefore, cortical DTI parameters will not correlate with gyration score beyond their common association with gestational age (GA).

MATERIALS & METHODS

Using an MR-compatible incubator with a high-sensitivity neonatal head-coil, we performed 37 MR exams in 26 premature newborns born at 24-33 weeks GA, and imaged at 25-37 weeks GA, with 2 serial exams in 11 infants. White matter injury was scored on T1- and T2-weighted images (4). The protocol included DTI and 3D spoiled gradient-recalled (SPGR) T1-weighted images that were reformatted into a consistent axial orientation. We identified 4 regions of interest on the DTI images (left and right pre and postcentral gyri) on 3 slices just above the roof of the lateral ventricles, and calculated the apparent diffusion constant (ADC), fractional anisotropy (FA), and eigenvalues (λ_1 , λ_2 , λ_3) in all regions. Using the axial SPGR images, we scored gyration similar to van der Knaap et al. (5), though we precisely calculated the ratio of gyral depth to gyral width in the pre and postcentral gyri, generating a continuous quantitative variable. We determined the correlation coefficients relating GA, gyration score, ADC, FA, and the eigenvalues, calculating the Fisher's p value for each relationship, and using a mixed random-effects model for multivariate regression.

RESULTS

There were no focal cortical abnormalities in any of the MR exams. White matter injury was absent in 11 exams, minimal in 16 exams, moderate in 7 exams, and severe in 3 exams. Cortical FA, major eigenvalue λ_1 , and ADC all showed significant inverse correlations with GA, whereas the minor eigenvalues λ_2 and λ_3 did not. Gyration score correlated positively with GA. Cortical gyration also correlated with cortical FA and λ_1 , but not ADC, λ_2 or λ_3 . In a mixed random-effects model accounting for GA, white matter injury, and repeated measures for serial scans, neither FA nor λ_1 showed any significant residual correlation with gyration score.

CONCLUSION

Quantitative DTI parameters in the developing peri-rolandic cortex of premature infants show no significant correlation with gyration, once the common association with gestational age has been accounted for. This suggests that DTI may provide unique microstructural information not revealed by macrostructural cortical gyration. Further research is ongoing to discover whether DTI is superior to conventional MR imaging in detecting abnormal cortical maturation and injury in premature newborns.

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KEY WORDS: Maturation, anisotropy, cortex

Paper 42 Starting at 11:03 AM, Ending at 11:11 AM

Regional Age Dependence of Human Brain Metabolites Involved in Apoptosis and Oxidative Stress Using Quantitative Proton MR Spectroscopy, a Neonatal Head Coil, and MR Compatible Incubator

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Children's Hospital Los Angeles
Los Angeles, CA

PURPOSE

Apoptosis and oxidative stress have been hypothesized to play a role in mediating perinatal white matter injury. The purpose of this study was to establish a normal longitudinal quantitative developmental database of metabolites which are known to be involved in apoptosis and oxidative injury in the developing brain using proton MR spectroscopy, a neonatal head coil, and MR-compatible incubator.

MATERIALS & METHODS

MR imaging was performed on a 1.5 T GE clinical scanner (GE, Milwaukee, WI). Single voxel 1H spectra were acquired using a single voxel PRESS sequence with an echo time of TE = 35 ms, a repetition time of TR = 1.5 sec, and 128 signal averages. The region of interest (ROI) size and position were placed in the peritriangular white matter and the occipital cortex (gray matter). Proton spectra were processed using the LCModel software (Stephen Provencher Inc., LCModel Version 6). The set consisted of 18 components including standard metabolites including those involved in apoptosis (lipids) and oxidative stress (glutamate, taurine, and creatine). Unpaired two-tailed students t-tests were used for statistical comparisons of gray and white matter of different age groups. An MR-compatible incubator with a neonatal head coil was used.

RESULTS

A total of 161 spectra were analyzed which fit the selection process of likely being a "normal" case (50 white matter spectra and 111 gray matter spectra). For the gray matter, 39 cases less than 1 year of age (including 21 neonates) were studied and 72 cases between 1 year and 15 years. For white matter, 18 cases were less than 1 year of age (including 6

neonates) were studied and 32 cases between 1 year and 15 years were studied. The metabolites known to be involved in oxidative stress demonstrates similar developmental trends in gray and white matter. Taurine is elevated in the neonatal period and decreases dramatically in levels after the first year of life ($p < 0.0001$). Glutamate levels remain low in the neonatal period and increase during development. ($p < 0.03$). There was no significant change in the levels of creatinine in both the gray and white matter. The major marker of apoptosis in our study (lipids) demonstrated different developmental profiles comparing gray and white matter. Lipids drop dramatically in concentration after the first year of life in the white matter ($p < 0.02$) compared to gray matter. The overall developmental trend of the standard metabolites (NAA, Choline and Myo-inositol) were similar in gray and white matter; NAA increases with age, ($p < 0.0001$), choline decreases with age ($p < 0.001$); and myo-inositol decreases with age ($p < 0.001$).

CONCLUSION

There is a critical period in the normal development of metabolites involved in apoptosis (lipids) and oxidative stress (taurine, creatine, and glutamate) in periventricular white matter. The developmental trends described in this data base support previously published studies. This study establishes quantitative longitudinal baseline data for the in vivo MR spectroscopic evaluation of abnormalities of metabolites which are involved in apoptosis and oxidative stress in neonates with perinatal white matter injury.

KEY WORDS: Perinatal white matter injury, glutamate

Paper 43 Starting at 11:11 AM, Ending at 11:19 AM

Brain Lateralization in the Neonate: A Functional MR Imaging Study

Erberich, S. G. • Bluml, S. • Panigrahy, A. • Tesoriero, L. • Friedlich, P. • Nelson, M. D. • Seri, I. • Gilles, F.

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Los Angeles, CA

PURPOSE

It is believed that lateralization of function between hemispheres takes place during the third trimester of intrauterine life. Some evidence of asymmetric brain development and early lateralization has been derived from intrauterine behavioral observation of more frequent right-arm movements compared to left-arm movements in 17- to 27-week-old babies. Direct measurements of cortical activation and subsequent demonstration of hemispheric asymmetries for lateralized sensory stimulation do not exist so far. The purpose of this study was to investigate, if lateralization exists in the preterm and term neonate by using functional MR imaging (fMRI) of a sensory-motor task in the left and the right hands.

MATERIALS & METHODS

Forty-two preterm and term newborn patients of the NICU in need for routine MR imaging were enrolled in this study (GA 25-41, mean = 37 weeks). All parents gave written consent for this IRB approved study. Patients were sedated before imaging using chloral hydrate (50 mg/kg). Newborns were prepared and placed in the MRCI (Lammers Medical

Technology, Lübeck, Germany and AIRI, Cleveland, OH) equipped with the newborn head-coil. During imaging vital signs, movement, and sleep state was constantly monitored. Imaging was performed with a 1.5 T MR system (CV/i, 8.4 software, General Electric Medical System, Milwaukee, WI). Functional acquisition: Single-shot gradient-echo echo-planar imaging (GR EPI) sequence (TR 3000, TE 50, FOV 180, FA 90, 64 x 64 matrix, 3 x 3 x 3 voxel resolution) and T2-weighted FSE images used to overlay. Two experiments, passive sensory-motor stimulation (A) of the left and the right hand, were conducted with the sleeping babies, provoking a grasp movement by repeated inflating/deflating of a rubber air-bulb (~2Hz) vs rest (R). We used an alternating block paradigm of RARARA lasting 30 s for each phase and a total scanning time of 3 minutes. Statistical Parametric Mapping software (SPM99) was used for spatial preprocessing and t-test statistics. Areas of activation/deactivation were identified ($p < 0.01$) and were accounted for hemispheric differences in the post and precentral gyri and in the whole cerebrum.

RESULTS

Morphologic findings: 24 neonates with normal gyri/sulci pattern; 16 with abnormal findings; 2 dismissed. Fifty-seven experiments were performed (33 right and 24 left hand). No adverse effects were observed. We found activation similar to the mature brain for the sensory-motor task in the contralateral gyrus pre/postcentralis (~58%), ipsilateral (~42%), bihemispheric thalamic, prefrontal, and occipital (~30%). In the abnormal cases, partial absence of activation could be linked to brain pathology. Head motion was insignificant, < 4 mm (translation) and $< 3^\circ$ (rotation), and was corrected. We found 13% dominance of contralateral BOLD changes in the sensory-motor areas whereas only 2% contralateral dominance overall in the cerebrum was found.

CONCLUSION

Functional MR imaging revealed a remarkably established sensory-motor response in the premature brains with incomplete myelination. Consistent evidence of deactivation suggests substantial differences between newborns and older children in blood oxygenation and tissue perfusion. Lateralization seems to be present, but not completely established, in the premature sensory-motor cortex at near-term and even less established between the whole hemispheres. We conclude, that the newborn seems to lateralize later during the postnatal and infant period, because studies on older infants report strong sensory lateralization.

KEY WORDS: fMRI newborns, brain lateralization, sensory-motor fMRI

Paper 44 Starting at 11:19 AM, Ending at 11:27 AM

Central Lobule of the Anterior Lobe of the Cerebellar Vermis High T2 Signal. A Sign of Profound Perinatal Hypoxia

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PURPOSE

Short periods of very severe HIE in children born at or close to term has been termed "profound hypoxia." This produces a highly characteristic pattern of gliosis in the posterior puta-

men, ventrolateral thalamus, paracentral white matter and hippocampus. We report abnormal high T2 signal in the anterior lobe of the cerebellar vermis, which we believe was the result of profound hypoxic ischemic encephalopathy in the perinatal period in term infants. We tested the hypothesis that this sign was associated with other signs of significant perinatal hypoxic damage.

MATERIALS & METHODS

Thirty patients with clinically and radiologically confirmed perinatal profound hypoxia close to term were included in the study. All patients had MR imaging at 1.5 T and ages at the time of scanning ranged from 1 to 24 years. The cranial MR images were reviewed by two pediatric neuroradiologists and were scored for the presence and severity of hypoxia/ischemia in the regions classically affected by profound hypoxia (Table 1). The clinical information recorded included gestational age and birth weight, 1 and 5 minute Apgar scores, lowest recordable heart rate in the perinatal period (normally a CTG reading) or at birth, age at MR imaging and clinical symptoms. The presence or absence of high T2 signal in the vermis and other sites was correlated with the extent of damage in classically affected regions.

RESULTS

Eighteen of 30 patients had high T2 signal in the vermis (Table 2). The total score of changes in the posterior putamen (0-3), ventrolateral thalamus (0-3), and paracentral white matter (0-3) was scored out of nine with 15 patients scoring 5/9 or less and 15 scoring 6/9 or more. Those with high anterior lobe of vermis T2 signal are more likely to have a high total score ($p = 0.02$). The presence of vermian damage also was correlated positively with extremely poor (0 or 1) one minute Apgar scores.

Table 1: Scoring System for Assessment of Classical Signs of HIE.

Putamen, thalamus and paracentral white matter	Score
No abnormality	0
Mild changes	1
Moderate changes	2
Severe changes	3

Table 2: Abnormalities on T2-Weighted MR in 30 Patients with Profound Hypoxia at Birth.

	Patients with subgroups of severity of changes	Patients with radiologic changes
Putamen	Mild 5 Moderate 16 Severe 8	29/30
Thalamus	Mild 4 Moderate 14 Severe 9	27/30
Paracentral white matter	Mild 7 Moderate 13 Severe 6	26/30
Hippocampus		13/30
Head of caudate nucleus		6/30
Anterior lobe of vermis		18/30

CONCLUSION

High T2 signal in the anterior lobe of the vermis probably represents gliosis secondary to hypoxia/ischaemia and is related to the severity of damage in the term infant. Damage to the anterior lobe of vermis central lobule may be associated with specific clinical features as are other signs of profound asphyxia.

KEY WORDS: Asphyxia, perinatal, vermis

Paper 45 Starting at 11:27 AM, Ending at 11:35 AM**Imaging and Clinical Follow-Up of Newborns with Seizures and Bright Diffusion-Weighted Imaging/Decreased Apparent Diffusion Coefficient Lesions**

Grant, P. E.^{1,2} • Matsuda, K. M.^{1,2} • Lopez, C. J.² • Sorensen, A. G.^{1,2} • Gonzalez, R. G.^{1,2} • Krishnamoorthy, K. S.¹

¹Massachusetts General Hospital, Boston, MA, ²A.A. Martinos Center for Biomedical Imaging, Charlestown, MA

PURPOSE

To determine the initial apparent diffusion coefficient (ADC) as well as imaging outcome of lesions identified on diffusion-weighted imaging (DWI) in term infants presenting with seizures and to determine the corresponding clinical outcome.

MATERIALS & METHODS

Term infants presenting with seizures, lesions with increased DWI signal, and decreased ADC in the first week of life, imaging follow-up of at least 1 month and clinical follow-up of at least 12 months were included in this study. Diffusion-weighted imaging patterns of abnormality were classified as 1) central (VL thalamus and lateral lentiform), 2) peripheral (watershed) or 3) focal vascular territory lesions. Initial DWI and ADC maps as well as follow-up T2-weighted images were coregistered to the initial T2-weighted images. Regions of interest were drawn on the initial DWI, transferred to ADC maps, and the mean ADC of the DWI abnormality determined. Abnormalities on follow-up T2-weighted images were compared to initial area of involvement on the presenting DWI study with volume loss and increased T2 signal qualitatively graded as smaller, similar, or larger than initial DWI abnormality. Standardized neurologic assessments were performed at a minimum of 12 months of age.

RESULTS

Fourteen patients met these criteria: one had a central pattern of DWI bright signal, 6 had peripheral patterns, 7 had vascular territory lesions. The mean ADC of pattern 1 was 1321 +/- 154, pattern 2 was 840 +/- 129 and pattern 3 was 840 +/- 167 x 10⁻⁶ mm²/s. (Contralateral normal regions could not be calculated in many cases due to the bilateral nature of the lesions and therefore ratios compared to normal were not attempted). Imaging follow-up was obtained between 3 months and 2 years and showed that the outcome of bright DWI areas was variable ranging from no detectable abnormality, volume loss with no T2 abnormality, volume loss with increased T2 signal, to cystic encephalomalacia with multiple outcomes occurring in each lesion. In general, the structural outcome of DWI lesions was a lesion smaller in size than the initial DWI abnormality but pattern 3 structural outcomes were worse than pattern 2. On neurologic assessments at 12 - 72 months, none had microcephaly or major motor disability and only 1 developed a seizure disorder.

CONCLUSION

In these selected cases, bright lesions on DWI with decreased ADC were not predictive of the severity of structural injury or of the degree of neurologic disability. Further neurologic follow-up and neuropsychological assessments at school age are required to fully evaluate the consequence of these lesions.

KEY WORDS: Neonate, seizures, ADC

Paper 46 Starting at 11:35 AM, Ending at 11:43 AM**Quantitative MR Diffusion Fiber Tracking to Assess White Matter Pathways in Newborns with Congenital Heart Disease**

Partridge, S. C. • Miller, S. P. • Berman, J. I. • Glenn, O. A. • McQuillen, P. • Henry, R. G. • Barkovich, A. • Ferriero, D. M. • Vigneron, D. B.

University of California San Francisco
San Francisco, CA

PURPOSE

We recently described the occurrence of preoperative stroke in newborns with D-transposition of the great arteries (TGA), a population at high risk of neurodevelopmental impairment (1). As neonatal repair of TGA results in near normal cardiovascular physiology, these newborns provide an opportunity to study the effect of early injury on subsequent neonatal brain development. MR diffusion tensor imaging (DTI) identifies developmental changes in white matter (WM) and gray matter microstructure (2). Diffusion-tensor imaging fiber tractography (DTT) enables the 3D segmentation of axonal bundles, based on preferential direction of water diffusion along axons, allowing quantitation of DTI parameters in specific WM pathways (3, 4). Our purpose was to investigate corticospinal tract development in newborns with TGA using pre and postoperative DTI and tract-based quantitation of fractional anisotropy (FA) and directionally averaged diffusion (Dav).

MATERIALS & METHODS

Six term newborns with TGA undergoing an arterial switch operation were studied with MR imaging and DTI pre and postoperatively at a median of 4 (range, 2 - 9) and 16.5 (range, 12 - 21) days of age respectively. Three newborns had focal injury on MR imaging: (1) stroke (caudate head), (1) germinal matrix hemorrhage (caudothalamic notch), and (3) paratrigenal WM injury. Imaging was performed using an MR-compatible incubator with a high-sensitivity neonatal head coil (5). Diffusion-tensor imaging was acquired with a 4.8 min single-shot, multi-repetition echo-planar sequence; TR/TE = 7s/100 ms, 3 NEX, 256 x 128 matrix, 360 x 180 mm FOV, 3 mm slice thickness, no gap. Diffusion gradients were applied in 6 directions with b = 0 and 700s/mm². DTT fiber tracks originating in cerebral peduncle were filtered through the internal capsule and centrum semiovale; FA and Dav were measured on images from voxels containing fiber tracks (4).

RESULTS

The corticospinal tracts had a median FA of 0.32 (range: 0.27 - 0.36) and median Dav of 1.12 mm²/s (0.98 - 1.26). Infants without injury had increasing FA with age, median 9.1% per week (2.9 - 17.2%), and decreasing Dav with age, median -5% per week (-4% to -8%). Infants with injury had less dramatic changes with age: median FA increase of 5% (2-5%), and median Dav decrease of -3% (-3 to -5%) per week. Of the infants with injury, one had expected DTI values and maturational changes (increasing FA and decreasing Dav with age), one had asymmetry in the corticospinal tracts with reduced FA (-7.5%) on the affected side at both time-points, and one had decreased Dav (-6%) on the affected side acutely.

CONCLUSION

These preliminary data suggest that DTT might be used to characterize development of specific WM tracts in newborns. Further investigation is needed to determine the pattern of abnormal microstructural development following focal brain injury, and whether maturational changes measured in specific WM tracts may help assess risk of neurodevelopmental impairment in newborns with congenital heart disease.

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KEY WORDS: Diffusion tensor imaging, neonatal, maturational changes

Monday Morning

10:15 AM - 11:45 AM
Room 602 - 603

(7) ELC Workshop A: PowerPoint for the Novice

— David S. Martin, MD

— John L. Go, MD

Monday Afternoon

1:00 PM - 1:30 PM
Ballroom 6 A

(8) ELC Lecture B: PDAs and the Radiologist

— Richard H. Wiggins, III, MD

Monday Afternoon

1:00 PM - 2:30 PM
Room 606 - 609

(9) Learning Disabilities in Childhood (ASPNR)

(9a) Overview of Learning Disorders: Current Concepts, Biological Foundations, and Research

— Bruce McCandliss, PhD

(9b) Functional MR Imaging in Children: Techniques, Current Usefulness

— Bruce McCandliss, PhD

(9c) Pediatric Applications of Functional MR Imaging

— Nolan R. Altman, MD

Moderators : Carolyn Cidis Meltzer, MD
Nolan R. Altman, MD

Overview of Learning Disorders: Current Concepts, Biological Foundations, and Research

Bruce McCandliss, PhD

Functional MR Imaging in Children: Techniques, Current Usefulness

Bruce McCandliss, PhD

Pediatric Applications of Functional MR Imaging

Nolan R. Altman, MD

Dr. Nolan R. Altman is currently and has been for the past 6 years the Chief of the Department of Radiology at Miami Children's Hospital. He is a volunteer associate professor of Radiology at the University of Miami School of Medicine. He received his Medical Degree from the University of Miami School of Medicine and completed a residency in Radiology at the Mount Sinai Medical Center of Greater Miami. He did a fellowship in Pediatric Neuro and Interventional Radiology at the Hospital for Sick Children in Toronto. He has been at Miami Children's Hospital for the past 20 years. He has written over 50 articles and 6 book chapters of which 7 recent articles and 2 chapters deal specifically with functional MR imaging.

LEARNING OBJECTIVES

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

- 1) Determine the role that fMRI plays in the pediatric patient
- 2) Identify Constraints of fMRI in the pediatric patient
- 3) Describe tasks to perform for successful fMRI in children
- 4) Describe the application of fMRI to cognitive function evaluation in children

PRESENTATION SUMMARY

The role of fMRI in children will be addressed. The use of fMRI in children is growing and the ability to investigate language and learning disorders makes this technique invaluable to investigate functions which are uniquely human and developed in childhood. Functional MR imaging at Miami Children's Hospital has been performed for the past 4 years with over 518 cases performed to date. Patients (290) have been evaluated for motor, language, visual, and cognitive mapping. Patients who benefit from this include those with preoperative planning for epilepsy and tumor surgery. Specific tasks will be presented that lend themselves to the pediatric patient. Investigational studies in sedated children for language and visual paradigms will be reviewed. Comparison of normal subjects with disorders of speech and learning (ADHD) will be addressed.

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Monday Morning

1:00 PM - 2:30 PM

Ballroom 6 B/C

(10) CT, MRI and PET Imaging in Treated Neck (ASHNR)

- (10a) Role of Positron Emission Tomography/CT in Imaging of the Neck

— Melanie B. Fukui, MD

- (10b) Postoperative Imaging of the Neck

— Daniel W. Williams, III, MD

- (10c) Posttreatment Imaging of Larynx

— David M. Yousem, MD

Moderators: Laurie A. Loevner, MD
David M. Yousem, MD

Role of Positron Emission Tomography/CT in Imaging of the Neck

Melanie B. Fukui, MD

LEARNING OBJECTIVES

- 1) Describe the advantages of combined PET/CT imaging over retrospective fusion
- 2) Review PET/CT in the evaluation of head and neck neoplasm
- 3) Recognize limitations of PET/CT imaging

PRESENTATION SUMMARY

FDG PET is effective for monitoring head and neck cancer. Lack of anatomical landmarks, variable physiologic uptake, and asymmetric tracer distribution in the neck, however, can confound image interpretation. This is particularly true in the treated neck where distortion of normal tissue planes makes detection of early disease recurrence difficult with static CT and MR imaging. Positron emission tomography/CT combines the physiologic data of PET with the anatomical precision of CT. The mobile head and neck benefits from prospective image fusion since movement between separately acquired CT and PET images may result in misregistration during retrospective image fusion. Indications for PET/CT in head and neck imaging will be discussed, including recurrent head and neck carcinoma, recurrent thyroid carcinoma, recurrent cranial base neoplasm, facilitating biopsy, detection of the undiscovered primary site, staging of head and neck cancer, and tumor surveillance (1). Potential pitfalls that include physiologic FDG uptake, scanner resolution,

recent radiation therapy, inflammatory processes, and tumors of low FDG avidity will be addressed. Cases that illustrate the use of PET/CT imaging in preventing misinterpretation of FDG PET in head and neck cancer will be presented.

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Postoperative Imaging of the Neck

Daniel W. Williams, III, MD

LEARNING OBJECTIVES

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

- 1) Review and summarize recently revised neck dissection classification
- 2) Distinguish with reconstruction techniques utilized following surgery for head and neck cancer
- 3) Recognize the expected posttreatment appearance of the neck on CT and MR imaging
- 4) Describe and identify complications and/or imaging pitfalls following treatment for head and neck cancer

PRESENTATION SUMMARY

Evaluating patients following treatment for head and neck cancer is difficult for the surgeon or radiation oncologist and for the radiologist. It is critical for the radiologist interpreting postoperative CT or MR exams to understand neck dissection (ND) and reconstruction techniques. Surgical changes following treatment for head and neck cancer complicate interpretation of imaging exams and can lead to erroneous conclusions. This presentation will attempt to give the radiologist a framework with which to approach these difficult postoperative exams. The various types of NDs for head and neck cancer will be discussed from both the surgical as well as the imaging point of view. The classification system that was revised in 2001 will be reviewed extensively. The typical imaging appearance of NDs will be highlighted, along with potential postoperative complications. Changes that are present routinely on CT or MR imaging following radical, modified radical, and selective NDs will be emphasized. Next, postoperative reconstruction techniques (myocutaneous flaps) will be discussed utilizing intraoperative photographs to illustrate the major procedures. The imaging appearance of these flaps then will be demonstrated, along with potential complications and/or imaging pitfalls. Finally, there will be a brief discussion of radiation changes visible on imaging exams and potential ways to detect the current tumors following treatment for head and neck cancer.

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Posttreatment Imaging of Larynx

David M. Yousem, MD

LEARNING OBJECTIVES

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

- 1) Recognize the normal postoperative appearance after voice conservation procedures
- 2) Apply knowledge of normal postop larynx surgery to be able to better detect recurrent tumors
- 3) Distinguish the contraindications for supraglottic and supracricoid laryngectomies

PRESENTATION SUMMARY:

After laryngeal conservation surgery the normal architecture of the larynx will be grossly distorted. How much normal cartilage and laryngeal anatomy remains is a function of whether a supraglottic laryngectomy, vertical hemilaryngectomy, or supracricoid laryngectomy has been performed. In the latter a single arytenoid from the supracricoid laryngectomy will be used to appose to the base of the tongue or epiglottis to create a sphincter for speech and airway protection. The thyroid cartilage and usually the epiglottis will have been removed unless a cricohyoidoepiglottopexy has been performed. The cricoid cartilage is elevated. Expect to see redundant mucosa and a narrowed laryngeal airway in the postoperative setting of this surgery. After a total laryngectomy the normal cartilaginous structures of the larynx will have been removed. In its place one will identify the "neopharynx" which is derived by suturing the two open ends of the hypopharyngeal and/or pharyngeal tissues together into a tube to be used for swallowing. This mucosa preoperatively would have been in contiguity with the laryngeal mucosa, and therefore marginal recurrences are possible.

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Monday Afternoon

1:30 PM - 2:00 PM

Ballroom 6 A

(11) ELC Lecture C: High Speed Connectivity and Networking for Work and Home

— Gerard J. Muro, MD

Monday Afternoon

2:00 PM - 2:30 PM

Room 611 - 612

(11A) National Library of Medicine
(NLM): PUBMED[®]/MEDLINE Short
Demonstration Lecture

— Linda Milgrom

Monday Afternoon

3:00 PM - 4:35 PM

Ballroom 6 B/C

(12a) Adult Brain: Neoplasms
(Scientific Papers 47 - 58A)

See also Parallel Sessions

(12b) Adult Brain: Cerebrovascular Disease and
Stroke

(12c) Head & Neck: General

(12d) Pediatrics: General and Developmental and
Congenital Disorders

Moderators: Aaron S. Field, MD, PhD
Pamela W. Schaefer, MD

MATERIALS & METHODS

Fifty patients with brain tumors near the pyramidal tracts were assigned randomly to trial (DTI navigation) or control group (traditional navigation). The cases in control group underwent traditional navigation surgery. Those in trial group underwent DTI and T1-weighted 3D navigational MR studies. FA maps were generated in workstation. The main white matter tracts were constructed by the FA datasets, and merged to the anatomical structure delineated from 3D navigational MR imaging. The relationship between the tumors and adjacent pyramidal tracts were segmented and reconstructed for three-dimensional visualization.

RESULTS

(1) There were 25 cases in trial group and 25 in control group, respectively. The statistical analysis confirmed well balance of main variations in two groups. (2) The lesions were resected completely in 13 cases (52.0%) of control group and 20 cases (80.0%) of trial group. (3) Postoperative aggravated contralateral extremities weakness or hemiplegia occurred in 72% cases of control group, while only 20.0% cases in trial group. (4) The mean Karnofsky scales were 69.58 ± 23.49 in control group and 84.80 ± 23.49 in trial group, respectively. The excellent outcome ratio (Karnofsky scale = 90~100) was 44.0% in control group and 72.0% in trial group, respectively. Fractional anisotropy MR images depicted white matter features not typically seen on conventional MR images (e.g., external capsule, internal capsule, callus, pyramidal tract). Fiber mapping images showed the ipsilateral pyramidal tract as either discontinuous due to impaired anisotropy or compressed due to mass effect in patients with brain lesions.

CONCLUSION

Diffusion tensor imaging provides new information regarding the detailed relationship between tumor and nearby white matter tracts applicable as important information in intraoperative neuronavigation and in planning brain tumor surgery. Diffusion tensor imaging should be used routinely in neuronavigation surgery of brain tumor involving pyramidal tracts to plan the optimal trajectory and ensure total resection of the lesions during operation, as well as to decrease potential disability and length of stay postoperatively.

KEY WORDS: Brain tumor, frameless stereotaxy, diffusion tensor imaging

Paper 48 Starting at 3:08 PM, Ending at 3:16 PM

Tracking Brain Tumor Invasion with MR Imaging by Measuring Subvoxel Distribution of Water Diffusion Rates

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²Medical College of Wisconsin, Milwaukee, WI

PURPOSE

The goal of this work was to develop a method of diffusion-weighted (1) MR imaging (DWI) to detect the presence of invasive tumor cells in the brain, outside of the main tumor in glioblastoma multiforme (GBM). Detection of invasion is crucial because these cells are blamed for the failure of conventional therapies to eradicate the tumor (2, 3).

Paper 47 Starting at 3:00 PM, Ending at 3:08 PM

Role of Diffusion Tensor Imaging in Neuronavigation Surgery of Brain Tumors Near Pyramidal Tracts

Hong, X.¹ • Wang, D.¹ • Wu, J.² • Shen, T.² • Chen, X.²

¹Jiangsu Province Hospital, Nanjing, CHINA, ²Huashan Hospital, Fudan University, Shanghai, CHINA

PURPOSE

To integrate three-dimensional reconstruction and images fusion of the pyramidal tract gained from MR diffusion tensor imaging (DTI) into a customized neuronavigation system and to evaluate its usefulness during brain tumor surgery.

MATERIALS & METHODS

Eight Sprague-Dawley rats were inoculated with C6 glioma cells to model GBM invasion. Cells were injected 3 mm below the dura. Rats underwent MR imaging 14-15 days after tumor inoculation. In three cases, glioma cells were labeled with the PKH26 fluorescent dye. Five healthy controls were imaged. The rats were anesthetized with urethane (1.2 g/kg). Rats were imaged on a Bruker 3T/60 scanner using DWI with a 64 × 64 matrix, FOV of 6.4 cm, slice thickness of 1.0 mm, and a TE of 46 ms. The b-value was varied from 0 to 6500 s/mm². Rats were injected with gadopentate after DWI, and T1-weighted images were acquired. The DWI data were fitted with the stretched-exponential model, described in reference 4. From this “a-DWI” analysis, a heterogeneity index α and a distributed diffusion coefficient (DDC), were obtained. Regions of interest (ROIs) were created in tumor, peri-tumor, normal gray matter (GM) and white matter (WM). Five mm thick frozen sections of the brain were examined by fluorescence microscopy (FM).

RESULTS

There was a significantly ($p < 0.01$, Student's t-test) lower value of α in voxels in the peri-tumor and tumor voxels than in GM. The value of α was significantly higher in the peri-tumor region than in WM, but not in the tumor region. DDC was significantly lower in the tumor and peri-tumor ROIs than in WM, but was only significantly higher than GM in the tumor ROI. FM confirmed the presence of tumor cells in the peri-tumor region. There was no increase in T2 or proton-density signal in the peri-tumor region, making edema an unlikely source of the change. Invasion could not be identified by conventional postcontrast images. The Figure shows that α and DDC can be used to identify the peri-tumor regions from normal voxels. Each point is the average value in a single rat.

CONCLUSION

A decrease in α tracks brain tumor invasion in the rat brain. Once developed for clinical use, aDWI may guide surgical removal invading GBM cells.

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4. Bennett KM, et al. *Magn Reson Med* 2003;50:727-734

KEY WORDS: DWI, invasion, brain tumor

The authors of this work have indicated the following affiliations/disclosures: National Institutes of Health/National Cancer Institute: CA082500; MCW Cancer Center.

Paper 49 Starting at 3:16 PM, Ending at 3:24 PM

Validity of Diffusion Tensor MR Imaging Prior to Neurosurgical Procedures: Preliminary Results

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PURPOSE

Preventing damage to eloquent areas and hence to improve the quality of surgical procedures is an important issue especially for brain tumors, which can infiltrate the pyramidal tract (PT). To keep morbidity low, its preoperative visualization is of utmost importance because it might be dislocated by tumor growth or invasion. Integrating diffusion tensor imaging (DTI) data into neurosurgical planning provides information about orientation, shape, and connectivity of fiber pathways. The aim of this study is to prove functional validity of presurgical-obtained DTI data.

MATERIALS & METHODS

Patients (n = 17) with unilateral high (n = 12) and low grade (n = 5) gliomas located in the vicinity of the PT underwent neuroimaging including DTI prior to navigational-guided tumor resection. Based on the combined constellation of the alteration of the T2 signal and the fractional anisotropy (FA) in sections of the PT adjacent to tumor tissue patients were classified in either dislocated, edematous, infiltrated, or disrupted. Measurements were performed on a 1.5 T scanner (Sonata, Siemens Medical Solutions, Germany), using a diffusion-weighted EPI sequence [TR/TE: 4000/129 ms; FOV: 230 x 230 mm; slice thickness: 2 mm; matrix: 128²; EPI-factor: 128; single b-value (750/1000) applied to 6 directions]. Postprocessing of the DTI data was performed with the “DTI-Task-Card” tool (MGH, Boston, MA). Additionally, contrast-enhanced T1 maps using a 3D FLASH sequence (TR/TE: 6/3 ms, $\alpha = 10^\circ$, FOV: 250 x 250 mm, matrix: 256², eff. slice thickness: 2 mm, and T2 maps (TR/TE: 3000/109 ms, $\alpha = 150^\circ$, FOV: 250 x 250 mm, matrix: 256 x 198, eff. slice thickness: 2 mm) were generated.

RESULTS

Tumor influence on PT was classified by its maximum disturbance of functional integrity, i.e., dislocation, edema, infiltration (n = 7) or disruption (n = 10) of at least one section of the PT. Whereas disruption of the PT was correlated with an overall deficit of contralateral motor performance in 50% (n = 5) of all glioma patients, infiltration of PT sections showed correlation to motor deficit in 29% (n = 2). Considering low-grade gliomas infiltrating or disrupting the PT, 50% (n = 1) and 67% (n = 2), respectively, had a motor deficit, whereas 20% (n = 1) and 43% (n = 3), respectively, were found in high-grade gliomas. Only 3 of all patients (18%) showed postoperative deterioration of motor performance.

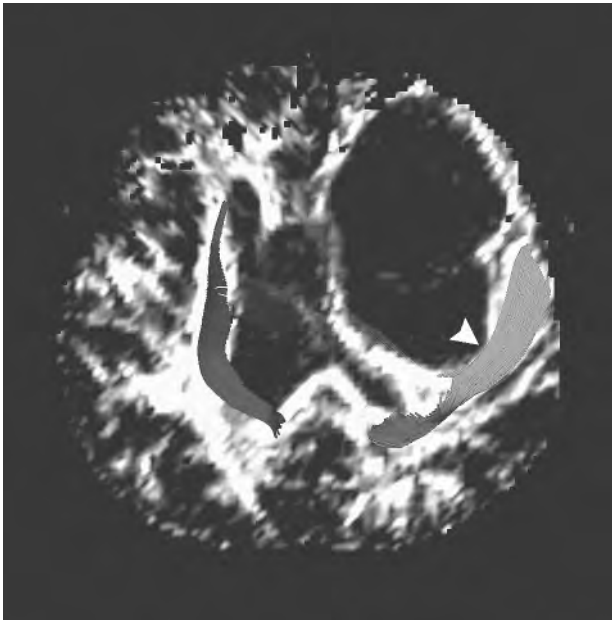


Figure: Pyramidal tract dystopia

CONCLUSION

Since neuroepithelial tumors differ in their behavior to infiltrate neuronal fiber pathways, preoperative neuroimaging including DTI can distinguish between disruption, infiltration, edema, and dislocation (see Figure). Although DTI requires final clinical validation it potentially offers an important tool for presurgical visualization of eloquent brain structures therefore preventing additional postoperative morbidity. Its integration into neuronavigational systems might possibly offer additional support to the surgeon. Intraoperative validation as well as postsurgical evaluation of the applied method is mandatory for future systematic studies.

KEY WORDS: Diffusion tensor imaging, brain tumors, pyramidal tract

The authors of this work have indicated the following affiliations/disclosures: Center for Biomarkers in Imaging, MGH Boston, MA, and Siemens Medizintechnik AG, Germany: providing the DTI-Task-Card.

Paper 50 Starting at 3:24 PM, Ending at 3:32 PM

Relationship between MR Imaging and Genetic Molecular Profiles in Oligoastrocytomas

Maccagnano, C. • Bruzzone, M. G. • Bissola, L. • De Simone, T. • Silvani, A. • Pollo, B. • Bianchessi, D. • Finocchiaro, G. • Eoli, M.

National Neurological Institute
Milan, ITALY

PURPOSE

To determine whether different genetic molecular profiles in oligoastrocytomas (OA) could be linked with peculiar features in MR imaging and histopathologic characterization of these tumors.

MATERIALS & METHODS

We investigated the correlations between MR imaging features on preoperative scan, histopathologic diagnosis, and the genetic molecular profile in 36 patients with grade II or grade III oligoastrocytomas, defined according to morphologic criteria. Loss of heterozygosity (LOH) with different microsatellite markers was studied in chromosomes 1p, 10q, 17p, and 19q in 36 OA (15 low grade and 21 high grade). The MR images were examined for location of the tumor, mass effect, sharpness of the border on T1-weighted images, homogeneity of tumor signal on T1- and T2-weighted images and presence of contrast enhancement.

RESULTS

In our series of 36 cases MR findings suggestive of high-grade gliomas were found frequently in oligoastrocytomas with LOH 10q while tumors with LOH 1p and 19q, although classified as anaplastic oligoastrocytomas had more often MR findings consistent with low-grade gliomas. A correlation was observed between 1p and/or 19q LOH and homogeneous T1 and T2 signal ($p = 0.02$, 15/22 patients) and with tumor location other than temporal. Indistinct border, T1 and T2 lack of homogeneity and presence of contrast enhancement were associated significantly with LOH on 10q ($p < 0.01$) (Table).

	Correlations between LOH and MRI features		
	LOH 10q	No LOH 10q	p(Fisher's exact test)
LOCATION			
Temporal	3/7	5/29	n.s.
MARGINS			
Undefined	6/7	8/29	0.008
T1/T2 SIGNALS			
Not homogeneous	7/7	10/29	0.002
MASS EFFECT			
Relevant	4/7	8/29	n.s.
ENHANCEMENT			
Yes	5/7	6/29	0.001
CALCIFICATIONS			
Yes	4/7	15/29	n.s.

CONCLUSION

Molecular alterations associated with cancer may be linked to certain physical or biochemical characteristics of tumor that can be imaged. Indistinct border, T1 and T2 lack of homogeneity and presence of contrast enhancement are the MR features that significantly correlate with LOH on 10q that predict the worst clinical outcome in OA. On the contrary LOH on 1p, independently from the histologic grade, is associated to T1/T2 homogeneity and to a more favorable prognosis. Our data indicate that the definition of genetic signatures in OA may complement very effectively the histologic diagnosis and, in addition to MR features, may improve the management of patients with oligoastrocytomas.

KEY WORDS: Loss of heterozygosity, MR imaging, oligoastrocytomas

Paper 51 Starting at 3:32 PM, Ending at 3:40 PM**Relative Cerebral Blood Volume Maps Corrected for Contrast Agent Extravasation Significantly Correlate with Glioma Tumor Grade whereas Uncorrected Maps Do Not**

Boxerman, J. L.¹ • Rand, S. D.² • Krouwer, H. G. J.² • Schmainda, K. M.²

¹Rhode Island Hospital, Providence, RI, ²Medical College of Wisconsin, Milwaukee, WI

PURPOSE

Relative cerebral blood volume (rCBV) estimates computed with dynamic susceptibility contrast MR imaging for high-grade tumors are artificially lowered by contrast extravasation through disrupted blood-brain barrier. We hypothesized that rCBV corrected for agent leakage would correlate significantly with histopathologic tumor grade, whereas uncorrected rCBV would not.

MATERIALS & METHODS

We computed rCBV maps for 40 patients with cerebral neoplasms. Prior to dynamic imaging, 0.05 mmol/kg of Gd-DTPA were administered to diminish T1 effects that might result from agent extravasation. For some very leaky high-grade tumors, this may be required to produce any discernable signal drop during bolus passage. Single shot gradient-echo images were acquired for 1 minute before and 2 minutes after a 0.25 mmol/kg bolus of Gd-DTPA (five 7 mm slices, TE/TR = 30/1000 ms, FOV = 24 cm, 64 x 64 matrix). DR2(t) derived from signal intensity data for each voxel was integrated numerically, with and without correction for contrast extravasation, to generate rCBV maps. A linear correction algorithm was applied to the signal time course to estimate the effects of contrast agent leakage (1, 2). Representative tumor rCBV was computed from a ROI placed over enhancing tumor, excluding regions of necrosis demonstrated on postcontrast T1-weighted images (spin echo, TE/TR = 11/500 ms, 256 x 256 matrix, NEX = 2), and was normalized to contralateral brain. The statistical correlation between normalized rCBV (corrected and uncorrected) and histopathologic tumor grade (determined from biopsy or gross resection) was computed with the Spearman rank correlation test, with significance threshold $p = 0.05$.

RESULTS

Ten, eight, and 22 patients had tumors classified as WHO grades II, III, and IV, respectively. Uncorrected normalized rCBV (mean $\pm$ std dev) for grades II, III, and IV was 1.28 ± 0.95 , 2.50 ± 1.71 , and 2.12 ± 1.82 , respectively. Corrected normalized rCBV was 1.29 ± 0.94 , 3.14 ± 1.85 , and 3.83 ± 2.07 . The percent difference between uncorrected and corrected rCBV (mean, (range)) was 2% (0-21%), 21% (0-142%), and 64% (0-254%) for grades II, III, and IV, respectively. In those cases where no difference was noted, predose Gd-DTPA probably limited T1 contamination during bolus passage by diminishing the extravasation gradient. The Spearman rank correlation coefficient between corrected rCBV and tumor grade was 0.54, with significant correlation ($p = 0.0004$). By comparison, uncorrected rCBV and tumor grade were not correlated significantly, with a Spearman rank correlation coefficient of 0.17 ($p = 0.29$).

CONCLUSION

For most high-grade gliomas, correcting for contrast agent extravasation is necessary to produce accurate rCBV estimates that are correlated significantly with WHO tumor grade. Artificially lowered rCBV may be construed erroneously to reflect a lower-grade tumor in the absence of correction.

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KEY WORDS: Cerebral blood volume, glioma grade, contrast agent leakage correction

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of Omniscan made by Nycomed-Amersham, Inc. for cerebral blood volume mapping.

Paper 52 Starting at 3:40 PM, Ending at 3:48 PM**Tumor Blood Flow Measurements at 3 T Using Continuous Arterial Spin Labeled Perfusion MR Imaging**

Wolf, R. L. • Wang, J. • O'Rourke, D. M. • Judy, K. D. • Melhem, E. R. • Detre, J. A.

University of Pennsylvania Medical Center
Philadelphia, PA

PURPOSE

To measure blood flow in brain neoplasms using continuous arterial spin labeled perfusion MR imaging, exploiting higher field strength (3 T) for improved signal-to-noise (SNR), and improved spin labeling due to increased T1.

MATERIALS & METHODS

Continuous arterial spin labeled (CASL) perfusion images were obtained in 12 contiguous axial sections from 7 subjects with brain neoplasms using a 3 T Siemens Trio scanner and product T/R head coil. Continuous arterial spin labeled was implemented using a postlabeling delay of 1200 msec as published previously for 1.5 T imaging (1, 2), and reduced RF amplitude of labeling pulses (22.5 mG) along with weaker labeling gradient to remain within FDA guidelines for RF deposition. Pathology of neoplasms included 1 diffuse large B cell lymphoma and 6 gliomas with WHO grade IV (n = 3), grade III (n = 1), and grade II (n = 2). Regions of interest (ROIs) were drawn over areas of increased perfusion. When tumor blood flow was not obviously increased (or decreased), ROIs were placed over regions of signal abnormality on conventional images (T2-weighted, FLAIR, and/or T1-weighted with contrast), excluding regions suggestive of vasogenic edema. Mirror ROIs were drawn in contralateral brain. Blood flow was calculated in each ROI as described previously (3). Global cerebral blood flow (CBF) was measured over all 12 imaging locations.

RESULTS

High quality quantitative perfusion images were obtained in all cases. The table shows tumor blood flow as a relative measure ($rTBF$ = ipsilateral/contralateral blood flow in ROIs) and as a normalized measure ($nTBF$ = $TBF/\text{global CBF}$) for each subject. Normalized TBF ($nTBF$) was > 1 for WHO grade III and IV neoplasms, and < 1 for WHO grade II neoplasms and the case of lymphoma. Relative TBF ($rTBF$) showed a similar distribution with one exception, where a grade II neoplasm showed $rTBF > 1$ (1.27). These results are consistent with those published previously using a pulsed arterial spin labeled (PASL) perfusion method at 1.5 T (4).

Normalized and Relative Tumor Blood Flow

Subject	Pathology	nTBF	rTBF
1	WHO grade IV	1.20	1.47
2	WHO grade IV	2.37	2.53
3	WHO grade III	2.30	2.15
4	WHO grade II	0.91	1.27
5	WHO grade II	0.62	0.74
6	WHO grade IV	1.29	1.15
7	Lymphoma	0.67	0.73

CONCLUSION

Continuous arterial spin labeled perfusion MR imaging at 3 T yields high-quality quantitative perfusion images. Preliminary results suggest that tumor blood flow normalized to global cerebral blood flow may provide the best distinction between high-grade (WHO grade III and IV) and low-grade neoplasms (WHO grade II and lymphoma in this study). This provides a noninvasive alternative to dynamic susceptibility contrast perfusion MR images, where measures of relative cerebral blood volume have been shown to be useful in predicting grade in brain neoplasms (5).

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KEY WORDS: Arterial spin labeling (ASL), cerebral blood flow (CBF), CNS neoplasms

Paper 53 Starting at 3:48 PM, Ending at 3:56 PM

Volume of Bolus Tracking Perfusion Abnormality Predicts Emergence of Contrast Enhancement in Glioblastoma Multiforme

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University of California San Francisco
San Francisco, CA

PURPOSE

External beam radiation therapy (XRT) is the most effective adjunctive therapy to control rapid tumor progression in high-grade gliomas following initial surgical resection. The residual contrast-enhancing tumor, widely accepted as the most malignant portion of the tumor, is an important target

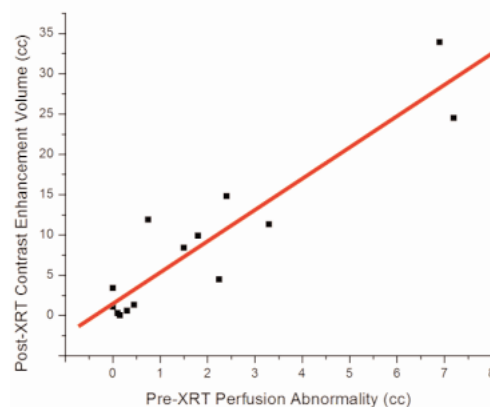
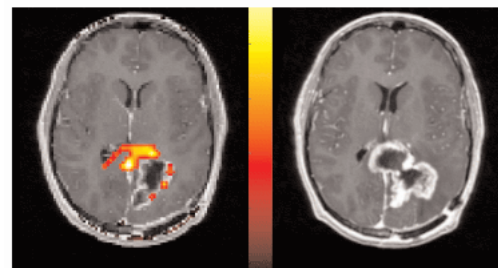
for radiation therapy (1). Contrast enhancement represents an area of blood-brain barrier breakdown and may not be synonymous with malignancy or angiogenesis. Bolus tracking perfusion MR imaging may be useful in assessing tumor angiogenesis indirectly (2, 3) and may provide additional information on changes in tumor characteristics during irradiation. We correlated the preirradiation bolus tracking perfusion abnormality with the postirradiation contrast enhancement pattern in patients with glioblastoma multiforme (GBM).

MATERIALS & METHODS

MR imaging was performed on 14 patients with untreated GBM using conventional anatomical imaging and bolus tracking T2*-weighted echo-planar MR imaging. All patients underwent subtotal resection with minimal residual contrast enhancement. The patients were imaged 4 weeks after surgery but before irradiation, after irradiation, and at 2 months interval thereafter. Peak height and percent recovery maps of the post bolus DR2* signal were calculated.

RESULTS

The volume of residual perfusion abnormality before irradiation correlates with the volume of contrast enhancement on T1-weighted images on both the immediate post-XRT scan ($n = 14$, $R^2 = 0.854$) and at 2 months post-XRT ($n = 8$, $R^2 = 0.934$). There was poor correlation ($n = 10$, $R^2 = 0.178$) between pre-XRT contrast enhancement and post-XRT contrast enhancement.



CONCLUSION

The results of our study suggest that there is a strong correlation between pre-XRT perfusion abnormality and emergence of contrast enhancement post-XRT, and that there is no correlation between pre-XRT contrast enhancement volume and post-XRT contrast enhancement volume for a given tumor in patients with GBM. The emergence of contrast enhancement following XRT probably represents dynamic

changes in tumor microvasculature as opposed to true emergence of recurrent tumor or failure of therapy. Contrast enhancement on a pre-XRT scan is nonspecific and may represent residual tumor or postsurgical granulation tissue, which may account for the lack of correlation between pre-XRT and post-XRT contrast enhancement volume. Progression of contrast enhancement may be expected in regions of tumor but not in regions of postoperative damage. Therefore, the pre-XRT residual perfusion abnormality may be a more accurate assessment of residual tumor than the immediate postoperative scan, and hence, a better target for radiation therapy planning.

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KEY WORDS: Perfusion, CBV, glioblastoma multiforme

The authors of this work have indicated the following affiliations/disclosures: 1. P50 CA97297; 2. National Institutes of Health NS045013; Research support.

Paper 54 Starting at 3:56 PM, Ending at 4:04 PM

The Steroid, Dexamethasone, Normalizes Brain Tumor Hemodynamics in a Rat Tumor Model as Indicated by Dynamic Susceptibility Contrast MR Imaging Perfusion Parameters

Quarles, C. C. • Ward, B. D. • Rand, S. D. • Krouwer, H. G. • Schmainda, K. M.

Medical College of Wisconsin
Milwaukee, WI

PURPOSE

The purpose of this study was to determine the therapeutic effect of dexamethasone on the rat 9L gliosarcoma model using perfusion-weighted dynamic susceptibility MR imaging (DSC MRI).

MATERIALS & METHODS

Twenty-four Fisher rats were inoculated with 9L gliosarcoma brain tumor cells. Of these, 15 were treated with 3 mg/kg of dexamethasone (i.p.) and 9 served as (untreated) controls. All MR experiments were performed on a 3 T system 14 days postinoculation. Just prior to the perfusion scan, a 0.05 mmole/kg loading dose of a gadolinium contrast agent was administered to diminish T1 leakage effects that may occur during the subsequent perfusion scan. Next, a 2 min simultaneous GE/SE EPI pulse sequence was used for the DSC perfusion scan. At 1 min, a 0.2 mmol/kg bolus of gadolinium was administered via the femoral vein. To determine the enhancing tumor area T1-weighted SE images were acquired after the DSC perfusion scan. Gradient echo and SE CBF, CBV, and MTT maps were created using the SVD approach (1). Intravoxel transit time distributions (TTDs) were calcu-

lated from the negative derivative of the residue function (2). The maximum difference between a voxel's cumulative TTD and a normal cumulative TTD (averaged over a normal ROI) also were computed. Unpaired two-tailed *t*-tests were used to compare the effects of treatment, using an $\alpha = 0.05$ level of significance.

RESULTS

A significant decrease in tumor volume following dexamethasone treatment was observed. The GE nCBF doubled (not significantly) while the GE nCBV and nMTT decreased significantly with treatment. The SE nCBF increased while the nMTT decreased, both significantly. Following treatment the tumor TTD appeared more like normal brain tissue. There was a significant change between the treated and untreated maximum differences for normal and tumor cumulative TTD.

CONCLUSION

In addition to the previously reported decreases in nCBV and vessel diameter (3) we now show that these morphologic changes in the tumor vasculature, following dexamethasone treatment, are accompanied by functional changes in the tumor hemodynamics. The normalization of nMTT following treatment may indicate an increased perfusion efficiency, so that it is more like that of normal tissue. Given that dexamethasone has been shown to inhibit VEGF expression, it is possible that the effect observed here results from the normalization of the balance of angiogenic factors, followed by a renormalization of the vascular morphology. Thus, the new perfusion parameters described here can provide more specific information about a tumor's vascular response to therapy, thus aiding in the optimization and evaluation of novel antiangiogenic therapies.

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KEY WORDS: Antiangiogenic therapy, dynamic susceptibility contrast, tumor perfusion

The authors of this work have indicated the following affiliations/disclosures: National Institutes of Health/National Cancer Institute: CA082500.

Paper 55 Starting at 4:04 PM, Ending at 4:12 PM

Stimulated Proliferation of Canine Bone Marrow Stromal Cells Following Exposure to Gadodiamide

Fujimoto, T. • Purdy, P. • May, H. • Miller, S. • McFarland, W. R. • Fujimoto, H. • Finnegan, M.

University of Texas Southwestern Medical Center
Dallas, TX

PURPOSE

Bone marrow stromal (BMS) cells isolated from the medullary canal of long bones possess the potential to differentiate into various cell types and have been proposed as a suitable source of stem cells for reconstructive tissue engineering in clinical therapeutics. In order to perform cellular transplants in various tissues, imaging techniques will need to be applied to detect effects from the transplants. MR

imaging should be suitable for this purpose. However, there are no reports investigating the effect of MR imaging contrast agent on BMS cells. The purpose of this study is to gauge the effect of an MR imaging contrast agent on canine BMS cells.

MATERIALS & METHODS

Adult, canine BMS cells were harvested from femoral shafts and placed in culture medium. After 14 days, cultures were divided and cells were plated and divided into nine groups, including test groups exposed to 0.01%, 0.1%, and 1% gadodiamide, test groups exposed to 10^{-3} , 10^{-4} , 10^{-5} , and 10^{-6} M free gadolinium ion, and control groups for each test set. Gadodiamide groups were further subdivided into 1, 6, 12, and 24 hours of exposure to the agent. Free gadolinium groups were obtained by using those concentrations of ion in the culture medium. Morphologic observation as well as analysis of cell proliferation by measurement of DNA synthesis and cell number were performed on both the gadodiamide and gadolinium groups.

RESULTS

Dilutions of gadodiamide ranging from 0.01% to 1% strongly stimulated the cell proliferation of canine BMS cell when compared to a control group [$p < .05(*)$ to $p < .01(**)$] (Figure). Time of exposure and density concentrations of gadodiamide affect canine BMS cell proliferation, with stimulation increasing with increasing exposure, but even 1 hour of exposure showed stimulation ($p < .05$). Although free gadolinium cation stimulated the proliferation of canine BMS cells, that effect is expressed more weakly than was observed with gadodiamide.

CONCLUSION

Gadodiamide strongly stimulates the cell proliferation of canine BMS cells in a dose- and time-dependent manner. Free gadolinium has a stimulatory effect which is less pronounced than the gadolinium-containing contrast material in canine bone marrow stromal cultures.

KEY WORDS: Gadodiamide, cellular proliferation, bone marrow stromal cells

Paper 56 Starting at 4:12 PM, Ending at 4:20 PM

Vascular Supply to Meningiomas: Correlation of Quantitative Analysis of T2* Susceptibility during Bolus Tracking Perfusion MR Imaging with Digital Subtraction Angiography

Hoghooghi, D. • Cha, S. • Cullen, S. P. • Lupo, J. M. • Halbach, V. V. • Dillon, W. P.

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San Francisco, CA

PURPOSE

Vascular supply to intracranial meningiomas assessed by digital subtraction angiography (DSA) is derived most commonly from the external carotid artery (ECA) but also from the internal carotid artery (ICA). To reduce tumor vascularity, preoperative embolization only can be performed safely on ECA branches. Dynamic contrast-enhanced bolus tracking T2* perfusion MR imaging (pMRI) provides quantitative assessment of tumor vascularity but the derived blood volume measurement may not be reliable in tumors without blood-brain barrier (1). The purpose of this study was to correlate quantitative analysis of T2* susceptibility during bolus tracking pMRI and DSA in meningiomas.

MATERIALS & METHODS

Thirty patients with previously untreated meningiomas were studied. All patients underwent preoperative anatomical and bolus tracking susceptibility pMRI as well as DSA. Axial fluid-attenuated inversion recovery and postcontrast T1-weighted spoiled gradient recalled images were acquired and used to define regions of T2 or T1 contrast enhancing abnormality. Bolus tracking pMRI was performed using susceptibility weighted images acquired during the first pass of Gd-DTPA (0.1mmole/kg) with a TR/TE of 1000-1250/54 ms, 35° flip angle, FOV of 26 ~ 26 cm², 128 ~ 128 acquisition matrix, and 3-6 mm slice thickness. The perfusion series was resampled to a 32 ~ 32 grid in-plane with a 16 x 16 cm² FOV so that the observed signal changes had sufficient signal-to-noise ratio to be analyzed reliably on a voxel-by-voxel basis. The T2* signal time curve was converted to relaxivity time curve, DR2*. Peak height (PH) and percent recovery of T2* relaxivity were normalized to the peak of a model curve function derived from normal-appearing brain based on histogram analysis of the precontrast echo-planar images. Voxels with PH values greater than twice the model curve were considered abnormal. The minimum percent recovery (MPR) of T2* signal at the end of the first pass was recorded.

RESULTS

Meningioma vascular supply, determined by DSA, was as follows: six ICA, ten ECA, and 14 mixed. In the ICA group (n = 6), the mean MPR was 42.5 ± 16.8 , in the ECA group (n = 10), the mean MPR was 21.8 ± 13.2 , and in the mixed group (n = 14), the mean MPR was 20.5 ± 17.11 . The difference in mean MPR between ICA and ECA ($p = 0.03$) and ICA and ECA plus mixed ($p = 0.02$) were significant. There was no statistical difference in the mean PH between the groups.

CONCLUSION

Our data suggest that percent recovery of T2* relaxivity during bolus tracking pMRI can provide indirect information on vascular supply to meningiomas. We found that the minimum percent recovery was significantly greater in meningiomas supplied predominantly by the ICA compared with the ECA. Wide variation of T2* signal recovery in the mixed group likely reflects variable contribution from both arterial branches. Further studies with image coregistration between pMRI and DSA will aid in more precise correlation of tumor vascular supply between the two methods.

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KEY WORDS: Meningioma, perfusion MR imaging, angiography

Paper 57 Starting at 4:20 PM, Ending at 4:25 PM**Primary Leptomeningeal Melanosis with Malignant Degeneration**

Keiper, M. D. • Jones, W. • Horsley, W.

Scottsdale Medical Imaging
Scottsdale, AZ

PURPOSE

To describe the radiographic findings, natural history, and applicable world literature of adult primary leptomeningeal melanosis through a clinical case report which utilizes new techniques for imaging of this entity.

MATERIALS & METHODS

This case report follows the clinical course of a 67-year-old white female with pathologically proven leptomeningeal melanosis with subsequent malignant degeneration from initial presentation in February 2002 to end stage disease in February 2003. Imaging studies performed at initial presentation in which the patient complained of right body numbness, right extremity weakness, and dizziness include CT, MR imaging, and four-vessel angiography. Subsequent follow-up imaging 6 months and 1 year after initial presentation include CT, MR imaging, and positron emission tomography CT (PET CT). Clinical findings, cerebrospinal fluid cytology, and surgical pathology will be presented.

RESULTS

At initial presentation, CT imaging demonstrated gyriform and sulcal high attenuation in the midline frontal regions presumed to represent hemorrhage. MR imaging revealed gyriform and sulcal high signal on short TR imaging with sulcal enhancement and prominent leptomeningeal veins interpreted by a nonneuroradiologist as probable cortical hemorrhage and/or subarachnoid hemorrhage from subacute infarction, vasculitis, or leptomeningeal vascular malformation. Angiography revealed no vasculitis and no vascular malformation. The patient subsequently was followed with presumed clinical diagnosis of subacute infarct. Follow-up CT scan at 6 months revealed no significant change. Ultimately, 1 year after initial presentation, the patient presented with marked deterioration in mental status and possible seizure

activity. MR imaging at that time revealed progression of signal intensity abnormality in the bilateral frontal regions, additional new leptomeningeal disease, and a new region of parenchymal edema, mass and enhancement in the medial left frontal lobe. This study was interpreted by a neuroradiologist who diagnosed probable primary leptomeningeal melanosis with malignant degeneration. Subsequent clinical examination and metastatic work-up revealed no primary skin, ocular or other soft tissue melanoma. In addition, PET CT revealed hypermetabolic activity in the regions of malignant degeneration in the brain with no activity in the regions of bland melanosis or within the remainder of the body. Pathologic analysis from surgical biopsy confirmed malignant melanoma with parenchymal invasion in the medial frontal lobe.

CONCLUSION

Primary leptomeningeal melanosis is a rare disorder with a nonspecific clinical presentation but with relatively specific radiographic findings which may be misinterpreted by general radiologists and neuroradiologists unaware of the potential manifestations of this disease. This case report describes these radiographic findings, follows the natural history of disease in a patient, and evaluates the use of PET CT in diagnosis and staging.

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KEY WORDS: Melanosis, leptomeningeal melanoma, positron emission tomography

Paper 58 Starting at 4:25 PM, Ending at 4:30 PM**Neuroblastoma Mimicking Subdural Hematoma at Onset**

Watanabe, K. • Koyama, M. • Ishii, M.

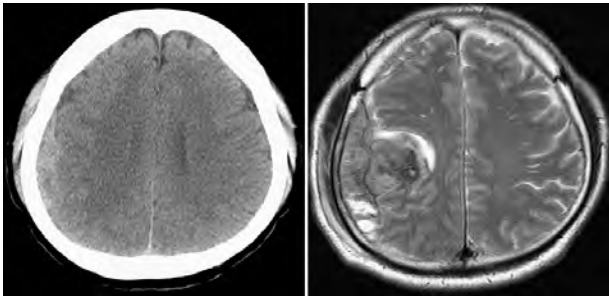
Okazaki City Hosiptal, Aichi, JAPAN
Okazaki, Aichi, JAPAN

PURPOSE

To describe a extremely rare condition of neuroblastoma originating from convexity dura matter. The symptoms and the CT findings had developed just like chronic subdural hematoma.

MATERIALS & METHODS

A 46-year-old man had been suffering from headache for a couple of weeks. CT scan revealed hyperdense subdural hematoma at right convexity (Figure - left). Since the hematoma was thin, the patient was observed at out-patient clinic for 2 months. As the hematoma gradually increased in size, aspiration procedure was attempted resulting in failure. MR imaging showed both sub/epidural mass lesion, which is isointensity on T2-weight images, compressing and invading the brain parenchyma with slight edema (Figure - right). MR imaging also depicted the adjacent skull abnormality.



RESULTS

The patient underwent craniotomy; the tumor was removed piecemeal. The tentative pathology reported the tumor as highly malignant. Irradiation therapy was scheduled but the tumor recurred before start. Immunohistochemical examination showed the tumor cells were positive for neuron-specific enolase, negative for synaptophysin and chromogranin. In conjunction with the histologic study, the final diagnosis of neuroblastoma was determined. Systemic studies revealed no other primary tumors and the tumor first appeared at epidural space, later extended to subdural space. These findings suggest the tumor is the neuroblastoma arising from convexity dura matter.

CONCLUSION

Neuroblastoma primarily originating from dura matter is extremely rare. We speculate the tumor occurred from the heterotopic neuroglial nest cells of meninges. At an early stage of growth, the tumor might arise in epidural space and spread along the dura matter. Later on, the tumor invaded subdural space and brain as well as the skull.

KEY WORDS: Neuroblastoma, dura matter, subdural hematoma

Paper 58A Starting at 4:30 PM, Ending at 4:35 PM

Cerebellopontine Angle Meningiomas: Differentiating Clinical and Imaging Features

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PURPOSE

When cerebellopontine angle (CPA) meningiomas extend into the internal auditory canal (IAC) they may be difficult to differentiate both clinically and radiologically from the more common vestibulocochlear schwannoma. The purpose of our study was to evaluate clinical and radiologic characteristics of CPA meningiomas with particular attention to IAC extension and frequency of sensorineural hearing loss (SNHL) vs other cranial neuropathies.

MATERIALS & METHODS

A retrospective review of all patients with CPA meningiomas who were evaluated or imaged at our institution over a 16-year period from 1987 to 2003 was performed. Clinical data collected included demographics, presenting symptoms, and recurrent or residual tumor following surgery. MR, CT, and angiographic data were reviewed to determine general imaging characteristics, and specifically record how often intracanalicular IAC extension, bony changes, and brain edema occurred.

RESULTS

Twenty-six patients with CPA meningioma were identified. There were 18 female and 8 male patients. Patient age ranged from 41 to 84 years, mean of 58 years. A variety of cranial nerves was affected in 19/26 cases, including V, VI, VII, VIII, IX, and X. Isolated ipsilateral SNHL was less common occurring in 7/26 cases. All masses were ovoid, isointense to gray matter signal on T1- and T2-weighted images with strong homogeneous enhancement and a centrifugal growth pattern. The vast majority 23/26 had a dural tail. Bony changes were variable on the available CT studies, with hyperostosis noted in 5/9 cases. Edema was an uncommon finding, noted in only 4/26 cases, whereas intracanalicular IAC extension occurred in 14/26 cases. Of the 17 patients who underwent surgery, 8/17 had residual or recurrent tumor noted on follow-up imaging.

CONCLUSION

CPA meningiomas most commonly present with complex cranial neuropathies with isolated SNHL as a less common feature. Differentiating imaging features of CPA meningiomas include centrifugal growth pattern and dural tails as well as hyperostosis. Given their unique location, morbidity is increased with multiple cranial nerves at risk and residual or recurrent disease is not uncommon. Intracanalicular IAC extension is a common finding. The combination of a complex clinical presentation mixed with radiologic appearance of a dural-based enhancing mass with IAC extension, dural tails, and hyperostosis, makes accurate preoperative diagnosis of CPA meningioma possible.

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KEY WORDS: Cerebellopontine angle, meningioma, MR imaging

Monday Afternoon

3:00 PM - 4:30 PM

Ballroom 6 A

(12b) Adult Brain: Cerebrovascular Disease and Stroke (Scientific Papers 59 - 69)

See also Parallel Sessions

(12a) Adult Brain: Neoplasms

(12c) Head & Neck: General

(12d) Pediatrics: General and Developmental and Congenital Disorders

Moderators: William T.C. Yuh, MD, MSEE
Robert D. Zimmerman, MD

Paper 59 Starting at 3:00 PM, Ending at 3:08 PM

Improvement in Angiographic Vasospasm with a 20-HETE Enzyme Inhibitor in a Subarachnoid Hemorrhage Dog Model

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Milwaukee, WI

PURPOSE

Arachidonic acid derivatives, primarily 20-hydroxyeicosatetraenoic acid (20-HETE), are potent vasoconstrictor metabolites produced in the cerebral circulation, which contribute significantly to subarachnoid hemorrhage (SAH)-induced vasospasm. 20-HETE is produced by enzymes of the CYP4A family that are expressed in the vascular smooth muscle of cerebral arteries. The effect on vasospasm of a new 20-HETE enzyme inhibitor, TS-011 (*N*-(3-Chloro-4-morpholin-4-yl)-phenyl-*N'*-hydroxyimidoformamide), was evaluated in a dog SAH model.

MATERIALS & METHODS

Subarachnoid hemorrhage was induced in 26 adult beagle dogs, weighing 9-12 kgs, by cisterna magna injection of autologous blood (0.5 ml/kg) on days #1 and #4. Angiography of the vertebrobasilar system was performed and venous blood and cerebrospinal fluid were collected on days #1, #4, and #7. Twelve dogs were used as controls. In 9 dogs, TS-011 was administered intravenously (1 mg/kg bid) starting on day #1 or day #4 through day #7. Five dogs received TS-011 on day #7 at the time that delayed vasospasm was documented, and then an additional angiogram was obtained 1 hour later. Angiographic images were obtained with the consistent inclusion of an external

caliper of known size, transferred digitally onto a computer program (Adobe Photoshop®), cropped to standardize magnification, and measurements of basilar artery diameters (BAD) were made at its mid-level to assess the degree of vasospasm.

RESULTS

Vasospasm was induced consistently in all dogs using the double cisterna magna injection method. Vasospasm was assessed as DBAD = change in basilar artery diameter relative to baseline BAD. In 12 control animals, vasospasm was significant at day #4 (DBAD 25%; range 14-35%) and severe at day #7 (DBAD 54%; range 32-90%). All but one of the TS-011-treated dogs showed significant vasospasm at day #4 (DBAD 31%; range 5-52%), and in all 14 but one of TS-011-treated dogs, angiographic vasospasm at day #7 (DBAD 24%; range 5-64%) was reduced by 50% relative to that seen in the control dogs. There was also significant reversal in the degree of vasospasm within 1 hour in the control dogs who received a bolus of TS-011 at day #7.

CONCLUSION

As there is evidence of enhanced turnover of fatty acids and increased formation of 20-HETE and other vasoconstrictor metabolites of arachidonic acid following SAH, as well as evidence that vasoconstrictor peptides (endothelin, angiotensin II, 5 HT) in turn stimulate 20-HETE formation in vascular smooth muscle, it is expected that blockade of 20-HETE synthesis will provide some degree of neuroprotection. In this study, experimental inhibition of 20-HETE appears to result in significant angiographic improvement of SAH-induced vasospasm in this dog model. The earlier 20-HETE blockade following the onset of SAH, the greater the angiographic improvement. 20-HETE enzyme inhibitors also appear to improve angiographic vasospasm on day #7 in the double injection model.

KEY WORDS: Arachidonic acid, subarachnoid hemorrhage, vasospasm

The authors of this work have indicated the following affiliations/disclosures: Taisho Pharmaceutical Co., Ltd.: Sponsoring research study.

Paper 60 Starting at 3:08 PM, Ending at 3:16 PM

Imaging of Microvasculature during Acute Ischemic Stroke with and without Intravascular Contrast Agent on High Resolution Ultrahigh Field MR Imaging in a Rodent Model with Histopathologic Correlation

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The Ohio State University
Columbus, OH

PURPOSE

To assess microvasculature during acute ischemic stroke in a middle cerebral artery occlusion (MCAO) rodent model using high resolution, ultrahigh field MR imaging with and without intravenous administration of an intravascular contrast agent.

MATERIALS & METHODS

High resolution, ultrahigh field (UHF) 8 T MR imaging and ultrasmall particle iron oxide (USPIO) intravascular contrast agent, (SHU555C, Supravist, Schering AG, Berlin) dosage were optimized to define microvasculature in 12 normal male Wistar rats. Ten male Wistar rats underwent 2-hour transient intraluminal filament MCAO while controlling physiologic parameters. They were imaged at 8 T on a Bruker AVANCE (Bruker, Billerica, MA) interfaced with Techon (Crown International, Elkhart, IN) gradient amplifiers and Manex gradients (Magnex Scientific, Abingdon, England) using a custom-built radio frequency front end. A custom made 4 cm diameter birdcage coil was tuned to the head of the rat at 340 MHz while the rat was in the prone position. Imaging included a gradient-recalled echo (GRE) sequence (TR/TE 700/16 msec, flip angle 45°, NEX = 2, 512 x 512 matrix and 78 mm in-plane resolution) and was acquired 2 and 24 hours postocclusion before and after USPIO (2 mg Fe/kg) administration. The rodents were sacrificed after the second imaging session and their brains removed and placed in 2, 3, 5-triphenyltetrazolium chloride (TTC). The brain specimens then were placed in a matrix and sectioned at 1 mm intervals. For each image including the area of infarction the number of cortical penetrating vessels and the number of deep gray nuclei perforators that could be identified before and after contrast enhancement were calculated separately for the infarcted and noninfarcted hemispheres. These values then were compared. Statistical significance was calculated using student t-test. TTC stained specimens were compared to 8 T images in order to identify whether the area of infarction corresponded to any changes in microvasculature on the 8 T images.

RESULTS

Microvasculature on the side of the infarction was more conspicuous than the unaffected side in all rats imaged at 2 hours. Table 1 indicates that microvascular conspicuity relative to the unaffected side was highest at 2 hours postocclusion and was significant both before and after contrast administration. At 24 hours the difference between the affected and the nonaffected side is less dramatic. USPIO contrast agent significantly increased microvascular conspicuity when administered.

Areas of increased microvasculature corresponded with the area of infarction identified on TTC stained specimens.

	Number of microvessels identified in the ischemic hemisphere and normal hemisphere			
	Number of vessels identified (mean standard error)			
	2hours without USPIO	2 hours with USPIO	24 hours without USPIO	24 hours with USPIO
Normal side	1.3 (0.6)	8.3 (1.3)	3.6 (0.7)	9.4 (0.8)
Ischemic side	7.9 (1.9)	11.8 (1.5)	4.4 (1.5)	10.8 (1.3)
p-value	0.0041	0.0033	0.5423	0.2048

CONCLUSION

Microvasculature appears to increase during hyperacute MCA occlusion and normalize after reperfusion. Ultrasmall particle iron oxide contrast agent does not appear to make a substantial impact on this particular observation but does increase microvascular conspicuity when imaging with GRE high resolution MR imaging at 8 T field strength.

KEY WORDS: Stroke, high field MR imaging, iron oxide

Paper 61 Starting at 3:16 PM, Ending at 3:24 PM

Measurement of Cerebrovascular Reserve Capacity by Contrast Perfusion CT, Dynamic Susceptibility Perfusion-Weighted MR Imaging and Positron Emission Tomography in Chronic Carotid Stenotic Disease

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PURPOSE

Evaluate in patients with chronic carotid stenotic disease the degree of correlation in measurements of cerebral blood flow and cerebrovascular reserve capacity between different methods: contrast perfusion CT, dynamic susceptibility perfusion-weighted MR imaging (PWI MR) and positron emission tomography (PET).

MATERIALS & METHODS

Nine patients, 3 with unilateral (left, 75%) and 6 with bilateral (< 75%, contralateral < 75%) internal carotid artery stenosis underwent perfusion CT, PWI MR and PET studies at rest and after acetazolamide challenge. CT CBF maps resulted from a deconvolution of the parenchymal time-concentration curves by a reference arterial curve. MR imaging CBF maps were calculated by deconvolution of the tissue susceptibility time curve with an arterial input function. PET was performed after bolus injection of 3.7 GBq [¹⁵O]H₂O with simultaneous arterial blood sampling. PET CBF maps were constructed using multilinear least-squares minimization procedure based on the one-compartment model (1). Cerebrovascular reserve capacity was determined by the difference in CBF before and after acetazolamide challenge. In corresponding transaxial tomograms CBF values were extracted using standardized regions of interest. Statistical analysis was performed using linear regression analysis and paired t-tests for matched variables.

RESULTS

Cerebral blood flow values measured by CT and MR imaging before acetazolamide challenge were correlated for both hemispheres ($r = 0.37$, $P < .05$, right hemisphere; $r = 0.46$, $P < .01$, left hemisphere). Cerebral blood flow values measured by PWI MR and PET were positively correlated for both hemispheres (right: $r = 0.72$, $P < .0001$; left: $r = 0.62$, $P < .0001$). Perfusion-weighted MR CBF values in basal ganglia and middle cerebral artery territory correlated at highest degree ($r = 0.76$, $P = .01$, $r = 0.96$, $P = .0001$, respectively) with those measured by PET. A correlation between perfusion CT and PET was noted only on the right hemisphere ($r = 0.35$, $P < .05$). The increase in CBF after acetazolamide challenge in perfusion CT was 13.8 ± 16.3 (median, 9.02) ml/min 100 g, in PWI MR 7.9 ± 21 (median, 5.52) ml/min 100 g, and in PET 9.5 ± 10.6 (median, 10.1) ml/min 100 g; nevertheless, a significant difference between methods was not observed.

CONCLUSION

Cerebral blood flow values measured by perfusion CT and perfusion-weighted MR imaging in patients with high-grade internal carotid artery stenosis before and after acetazolamide challenge were correlated significantly. More distinct correlation was detected between PW MRI and PET imaging, confirming in this way recent work (2). Perfusion CT and PWI MR can provide measurements of vascular reserve capacity for patients with chronic carotid stenosis comparable to PET. Additionally, larger studies are required to further substantiate that vascular reserve capacity measurements by perfusion CT, PWI MR are as reliable as those obtained with PET.

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KEY WORDS: Brain perfusion, correlation, CT, MR, PET

Paper 62 Starting at 3:24 PM, Ending at 3:32 PM

Relationship between Reduced Apparent Diffusion Coefficient Values, Perfusion Deficits, and Metabolic Changes in Acute and Hyperacute Ischemic Stroke

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PURPOSE

Acute stroke is characterized by a reduction of the apparent diffusion coefficient (ADC) values, often a perfusion deficit and a diffusion-weighted/perfusion-weighted imaging (DWI/PWI) mismatch. Recent studies indicate that parts of the DWI/PWI mismatch and the DWI lesion may still be viable in the acute and hyperacute phase of stroke. In the past, only few studies have investigated the potential of spectroscopy (SVS, CSI) as an additional tool for better differentiation of reversibly and irreversibly damaged tissue, mainly due to the long time required for data acquisition. In this study, multiple spin-echo spectroscopic imaging (MSE-SI or TSI) (1) could be performed in approximately 6 minutes providing spectroscopic images with a spectral resolution sufficient for absolute quantification of lactate (Lac) and N-acetylaspartate (NAA).

MATERIALS & METHODS

Ten acute and hyperacute stroke patients were examined within 24 hours of symptom onset. The MR examinations were performed on a 1.5 T Philips Gyroscan Intera scanner including DWI, MSE-SI (acquisition of four spin-echoes at multiples of 144 ms) and PWI. For an accurate detection of Lac, the lipid signals from the skull were suppressed using volume preselection by PRESS and multiple-slice outer vol-

ume suppression. Spectra quantification was performed by peak integration using the csx2 software (courtesy of PB Barker, JHU Baltimore, MA). Absolute concentrations were determined using the phantom replacement method adapted to the acquisition of multiple spin-echoes. The spectroscopic quantification method was validated in vitro for Lac and NAA and in vivo for NAA (2). For coregistration of MR images (ADC, PWI) with MSE SI three adjacent slices with reduced matrix size were added.

RESULTS

In 9/10 acute stroke patients we found metabolic changes (increased Lac and normal or decreased NAA) extending beyond the borders of the ADC lesion (3). The only patient without Lac outside the ADC lesion had no DWI/PWI mismatch. Perfusion-weighted imaging data from 5 acute stroke patients could be analyzed in terms of rCBF (Stroke Tool, HJ Wittsack). Figure 1 shows the maximum Lac concentration inside and outside the ADC lesion plotted vs the respective change of rCBF (in % compared to contralateral). Maximum Lac of 18 mmol/l was observed at a decrease of rCBF to 22%.

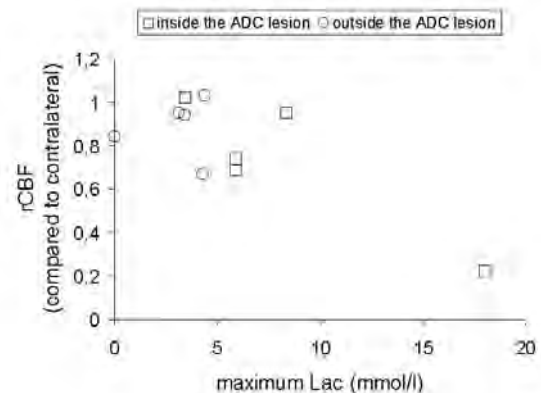


Figure. rCBF plotted vs maximum Lac.

CONCLUSION

Spectroscopic imaging can be used as an additional tool for assessment of tissue damage in acute stroke. Lac is correlated with the perfusion deficit.

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KEY WORDS: Acute stroke, spectroscopic imaging, lactate

Paper 63 Starting at 3:32 PM, Ending at 3:40 PM

Hemorrhagic Transformation after Intraarterial Thrombolysis: Clinical Utility of Pretreatment CT Perfusion

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PURPOSE

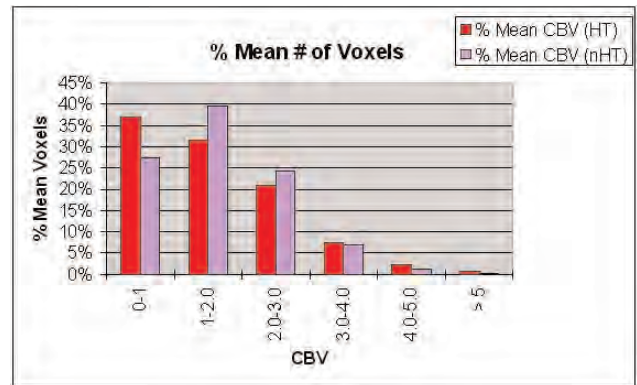
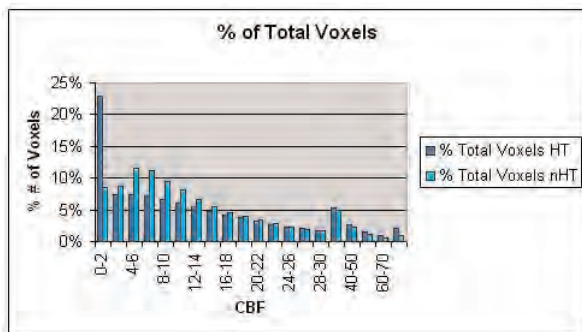
Hemorrhagic transformation (HT) is a major complication of thrombolytic treatment for acute ischemic stroke. Our purpose was to assess the clinical utility of CT perfusion in differentiating infarctions that will undergo hemorrhagic transformation from those that will not in patients treated with intraarterial thrombolysis.

MATERIALS & METHODS

Quantitative CT perfusion images were obtained in 8 patients with proximal MCA emboli who presented within 6 hours of stroke onset and who were treated successfully with intraarterial thrombolysis. Follow-up CT or T2-weighted MR images were obtained at 1 to 8 days. Five of 8 MCA infarctions had hemorrhagic transformation. Regions of interest (ROIs) were drawn around the whole region of low CBF on each slice in each patient and were copied onto the CBV maps. The cerebral blood flow and cerebral blood volume for each pixel within the ROIs were calculated. Subsequently, the percentage of pixels with a CBF of less than 2 ml/100 gm/min and the percentage of pixels with a CBV of less than 1 ml/100 gm were calculated.

RESULTS

A significantly greater percentage of pixels possessed lower CBFs (less than 2 ml/100 gm/min) in HT lesions compared with non HT lesions (23% vs 8%, $p < 0.001$). All 5 patients with HT had a higher number of voxels with CBF less than 2 ml/100 gm/min compared to the 3 patients without HT. A significantly greater percentage of pixels possessed lower CBVs (less than 1 ml/100 gm) in HT lesions compared with non HT lesions (37% vs 27%, $p < 0.001$). Four of 5 patients with HT had a higher number of voxels with CBV less than 1 ml/100 gm compared to 2/3 patients without HT.



CONCLUSION

Acute infarctions that undergo hemorrhagic transformation have a significantly higher percentage of pixels with low CBFs and CBVs. Cerebral blood flow and CBV values may be useful in differentiating ischemic tissue likely to hemorrhage from ischemic tissue that is not likely to hemorrhage, and may be important in differentiating patients likely to benefit from intraarterial thrombolysis from those who are not.

KEY WORDS: CT perfusion, hemorrhagic transformation, acute stroke

Paper 64 Starting at 3:40 PM, Ending at 3:48 PM

Usefulness of Diffusion- and Perfusion-Weighted MR Imaging for Prediction of Hemorrhagic Transformation Following Acute Stroke

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PURPOSE

We intended to evaluate the usefulness of diffusion- and perfusion-weighted MR imaging in acute stroke for prediction of subsequent hemorrhagic transformation.

MATERIALS & METHODS

Forty patients of acute stroke with subsequent hemorrhagic transformation were included. For comparison, we randomly selected a nonhematoma group which consisted of 48 patients with acute territorial infarction. MR imaging was performed in hyperacute stage and within 7 days after symptom onset. Our imaging protocol included T2-, diffusion-, perfusion-weighted images, gradient-echo images and MR angiography. Patients with hematomas were categorized into large ($n = 18$) and small hematoma group ($n = 22$); the inclusion criterion for large group was the presence of mass effect of the hematoma. Infarct volume and relative apparent diffusion coefficient (rADC) value of the infarct were measured by using diffusion weighted images (DWI) and compared among the two hematoma groups and nonhematoma group. Perfusion-weighted MR was obtained in 22 patients of hematoma groups and 32 patients of nonhematoma group and relative cerebral blood volume (rCBV) and relative cerebral blood flow (rCBF) were compared among the three groups.

RESULTS

Infarct volume in large, small, and nonhematoma groups was 72.1 ± 49.5 , 40.8 ± 25.2 , 20.2 ± 28.2 cc, respectively. The difference was significant among the three groups (ANOVA, $p < 0.05$), but not significant between small and non-hematoma groups (Bonferroni post hoc, $p > 0.05$). Relative apparent diffusion coefficient value was 59.1 ± 10.1 , 66.8 ± 11.5 , 72.7 ± 14.8 %, respectively and the difference was significant between large and nonhematoma groups (Bonferroni post hoc, $p < 0.05$), but not significant between large and small and small and nonhematoma groups ($p > 0.05$). Relative cerebral blood volume in large, small and non-hematoma groups was 26.2 ± 11.1 , 44.6 ± 24.5 , and 48.3 ± 18.8 %, respectively and rCBF was 19.7 ± 8.0 , 37.5 ± 19.1 , and 41.2 ± 19.5 %, respectively. The difference of rCBV and rCBF value between large and small hematoma groups were not significant, but it was significant between large and non-hematoma groups (ANOVA, Bonferroni post hoc, $p < 0.05$).

CONCLUSION

The large hemorrhagic transformation group had larger infarct volume, lower rADC value, and lower rCBV and rCBF values on initial DWI or perfusion-weighted images compared to small or nonhematoma groups. Our conclusion is diffusion- and perfusion-weighted images may be useful in predicting hemorrhagic transformation in acute infarction patients.

KEY WORDS: MR imaging, stroke

Paper 65 Starting at 3:48 PM, Ending at 3:56 PM

Measurement of Cerebral Hemodynamics with Dynamic Perfusion CT: Comparison with Pre and Postacetazolamide [^{15}O]H $_2\text{O}$ Positron Emission Tomography in Patients with Carotid Artery Stenosis

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PURPOSE

Our purpose was to evaluate the accuracy of cerebral blood flow (CBF) measurements obtained by using dynamic perfusion CT, including the effect of arterial input function (AIF) selection, compared with those obtained by positron emission tomography (PET) in patients with internal carotid artery (ICA) stenosis before and after acetazolamide challenge.

MATERIALS & METHODS

Twelve patients with ICA stenosis underwent dynamic perfusion CT and PET studies at rest and after acetazolamide challenge. Cerebral blood flow values on perfusion CT resulted from a deconvolution of parenchymal time-concentration curves by a reference arterial curve. The region of interest (ROI) that provided the AIF was placed in the larger of the two anterior cerebral arteries; the venous outflow function ROI was selected automatically by the perfusion software. The same protocol was followed placing the AIF ROI in each A. choroidea anterior, which originates directly from ICA, and was identified in the lower level of the scanned section in 9 patients, who subsequently were classified into two groups. Group A included 4 patients with uni-

lateral (right = 75%) and group B 5 patients with bilateral (> 75%, contralateral < 75%) ICA stenosis. Cerebral blood flow was measured by [^{15}O]H $_2\text{O}$ PET using multilinear least-squares minimization procedure based on the one compartment model. In corresponding transaxial tomograms CBF values were extracted using standardized ROIs. Statistical analysis was performed using linear regression analysis and paired t tests for matched variables.

RESULTS

Arterial input function in anterior cerebral artery in perfusion CT delivered in all patients CBF values that were correlated positively with those measured by PET before and after acetazolamide challenge (Table 1). In group A, AIF in anterior choroidal artery ipsilateral as well as contralateral to the stenotic ICA delivered CBF values significantly correlated with those obtained by PET. Nevertheless, a more distinct correlation was observed with AIF ipsilateral to the stenotic ICA. In group B, the choice of AIF ipsilateral or contralateral to the stenotic ICA made statistically significant difference ($P < .01$) between CT and PET CBF values before and after acetazolamide challenge (Table 1). Furthermore, the choice of AIF ipsilateral to the more affected ICA delivered in patients of group B CBF values significantly correlated with those measured by PET (Table 1).

Table 1. Correlation of CBF values measured by perfusion CT and PET, including AIF selection

	AIF in anterior cerebral artery		AIF in right anterior choroidal artery		AIF in left anterior choroidal artery	
	Before challenge	After challenge	Before challenge	After challenge	Before challenge	After challenge
Group A (right ICA stenosis) n=4	r=0.6 P < .05	r=0.5 P < .05	r=0.7 P < .001	r=0.6 P < .001	r=0.4 P < .05	r=0.5 P < .05
Group B (bilateral ICA stenosis) n=5	r=0.5 P < .01	r=0.6 P < .01	r=0.3 P > .05	r=0.3 P > .05	r=0.5 P < .05	r=0.6 P < .05
Group B1 (>75% right ICA stenosis) n=2	r=0.7 P = .01	r=0.6 P < .01	r=0.4 P > .05	r=0.6 P < .05	r=0.5 P > .05	r=0.6 P > .05
Group B2 (>75% left ICA stenosis) n=3	r=0.6 P < .01	r=0.7 P < .01	r=0.4 P > .05	r=0.4 P > .05	r=0.6 P < .01	r=0.6 P < .01

CONCLUSION

The choice of the reference artery for the deconvolution process in perfusion CT is an important concern for the assessment of cerebral hemodynamics. Cerebral blood flow values measured by PET in patients with carotid artery stenosis before and after acetazolamide challenge correlated with perfusion CT measurements using AIF in anterior cerebral artery or ipsilateral to the side of the more affected carotid artery.

KEY WORDS: Perfusion CT, carotid artery stenosis, PET

Paper 66 Starting at 3:56 PM, Ending at 4:04 PM**Evaluation of 20-Hydroxyeicosatetraenoic Acid Levels in Normal and Abnormal Blood and Cerebral Spinal Fluid**

Hacein-Bey, L. • Roman, R. J. • Lemke, D. M. • Lauer, K. K. • Varelas, P. N. • Torbey, M. T. • Cusick, J. F. • Harder, D. R.

Medical College of Wisconsin
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PURPOSE

The role of vasoconstrictors in stroke and vasospasm is being investigated increasingly. There is evidence of enhanced turnover of fatty acids and increased formation of vasoconstrictor metabolites of arachidonic acid (AA) following stroke and intracranial hemorrhage. 20-hydroxyeicosatetraenoic acid (20-HETE) is the primary vasoconstrictor metabolite of AA produced in the cerebral circulation. 20-HETE is produced by enzymes of the CYP4A family expressed in vascular smooth muscle arteries. The mechanism of action of 20-HETE is via activation of protein kinase C and depolarization of vascular smooth muscle cells, resulting in inhibition of large conductance Ca^{2+} channel sensitive K_{Ca} channels. 20-HETE also increases Ca^{2+} influx by increasing the activity of L-type Ca^{2+} channels in the cerebral vasculature and plays a critical role in cerebral autoregulation in the rat. Vasoconstrictor peptides (endothelin, angiotensin II, and serotonin) stimulate 20-HETE formation in vascular smooth muscle and 20-HETE potentiates vasoconstrictor response to these agents. There is recent evidence that inhibition of the synthesis of 20-HETE reduces the acute fall in CBF following subarachnoid hemorrhage (SAH) and reduce infarct size following ischemia and reperfusion in the brains of rats. We sought to 1) identify 20 HETE levels in the blood and CSF of normal human subjects and patients with ischemic stroke and subarachnoid hemorrhage; 2) determine the degree of 20-HETE level elevation in stroke and SAH.

MATERIALS & METHODS

Blood and CSF samples were obtained from patients with subarachnoid hemorrhage (SAH) (n = 10), ischemic stroke (n = 10) and normal subjects (n = 10). Normal controls were patients without neurologic conditions admitted for minor abdominal surgery under spinal analgesia. In stroke patients, CSF was collected only after ruling out intracranial masses and herniation. In SAH patients, CSF was collected from ventricular or lumbar drains. Clinical data prospectively collected included neurologic condition upon admission (Rankin score, Hunt & Hess score), infarct and hemorrhage size, comorbidities, and TCD and angiographic data. 20-HETE levels were measured using LC/MS/MS assays.

RESULTS

In 12 control patients, the concentrations of 20-HETE in the CSF were below the minimal detectable level, < 20 pg/ml. Normal levels of 20-HETE in the plasma were 275 pg/ml, (range 184-425). In SAH patients, marked elevations in CSF 20-HETE levels were found with a mean level of 146 pg/ml (range 20-331). There was a trend toward a correlation between elevated 20-HETE levels and severity of vasospasm assessed by TCD and angiography. In stroke patients, 20-HETE levels, both in blood and CSF, were not significantly different from those of normal controls.

CONCLUSION

20-HETE levels can be measured accurately in normal subjects, and stroke and SAH patients. 20-HETE levels are markedly elevated in the CSF of patients with SAH, and may be commensurate to the degree of vasospasm present in these patients. In stroke patients, no significant increase in 20-HETE levels, in either the blood or CSF, could be identified as compared to normal subjects.

KEY WORDS: Arachidonic acid, stroke, subarachnoid hemorrhage

The authors of this work have indicated the following affiliations/disclosures: Taisho Pharmaceutical Co., Ltd.: Sponsoring research study.

Paper 67 Starting at 4:04 PM, Ending at 4:12 PM**Intrathecal Steroid Ameliorates Infarction Volume in Focal Cerebral Ischemia in Rats**

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²Humboldt University of Berlin, Berlin, GERMANY

PURPOSE

The aim of our study was to evaluate the neuroprotective efficacy of intrathecally administered triamcinolonacetone (TCA) on infarction volume in acute focal cerebral ischemia in rats.

MATERIALS & METHODS

Focal cerebral ischemia was induced in 102 Wistar rats using an endovascular occlusion technique of the middle cerebral artery (MCAO). In a first dose-finding study, different doses of TCA (0.3, 0.03, 0.012, 0.006, or 0.003 mg/kg bodyweight) were administered into the cisterna magna of 12 rats each 30 minutes after MCAO. Twelve animals received equivalent saline intrathecally. In a second MR-controlled confirmation study, the neuroprotective efficacy of the most effective dose was compared to controls in 15 rats each. Infarction volume was calculated 24 hours after MCAO by TTCstaining in all animals.

RESULTS

Experiment 1: Compared to controls ($18.2 \pm 5.0\%$), infarction volume was significantly reduced using TCA at a dose of 0.012 mg/kg ($13.4 \pm 5.3\%$, $p = 0.04$). TCA 0.03 mg/kg ($17.7 \pm 6.9\%$, $p = 0.84$), 0.006 mg/kg ($15.9 \pm 4.2\%$, $p = 0.24$), and 0.003 mg/kg ($14.5 \pm 5.2\%$, $p = 0.11$) did not reduce infarction size significantly, whereas TCA 0.3 mg/kg resulted in bilateral infarction with increased infarction volume ($19.8 \pm 5.0\%$, $p = 0.49$). Experiment 2: MR imaging (diffusion-weighted images, T1-weighted images) confirmed successful MCAO and intrathecal administration in all animals. Compared to controls ($20.0 \pm 8.0\%$) infarction volume was reduced significantly in animals treated with TCA 0.012 mg/kg ($13.4 \pm 6.5\%$, $p = 0.02$).

CONCLUSION

Intrathecally administered steroid triamcinolone acetonide may reduce infarction volume significantly in permanent focal cerebral ischemia in rats. Further studies, focusing on long-term effects and clinical outcome, are necessary to assess the therapeutic value.

KEY WORDS: Cerebral infarction, glucocorticoids, neuroprotection

Paper 68 Starting at 4:12 PM, Ending at 4:20 PM**Middle Cerebral Artery Infarction: Relationship of Cavernous Carotid Artery Calcification**

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¹Johns Hopkins Hospital, Baltimore, MD, ²University of Pennsylvania School of Medicine, Philadelphia, PA

PURPOSE

This study was designed to determine whether calcification of the cavernous carotid artery could be as predictive of cerebrovascular events as coronary artery calcification scoring is indicative of myocardial infarctions. In our retrospective analysis we sought to correlate grade of cavernous carotid artery calcification with middle cerebral artery (MCA) distribution infarctions.

MATERIALS & METHODS

The unenhanced brain CT scans of 40 MCA distribution stroke patients, 34 non-MCA distribution stroke patients, and 94 age-matched nonstroke control patients were reviewed. The degree of circumferential calcification and thickness of calcification were graded for the cavernous carotid arteries on the bases of CT bone window findings. Scores were determined for the left and right cavernous carotid artery for the patients with infarctions and for the control subjects only the higher of the two scores was recorded with no designation of the side. Two-sample t tests and Fisher's exact tests were used to detect differences between all stroke cases and all controls, MCA stroke cases and non-MCA stroke, MCA stroke cases and controls, non-MCA stroke cases and controls, and side of higher calcification and side of stroke.

RESULTS

There were no statistically significant differences between the cavernous carotid artery calcification scores of the various groups that were compared. In addition, the results were not affected by the manner in which calcification was scored; the circumferential involvement, thickness of calcium, or the aggregate of the two yielded no significant difference between the groups analyzed herein.

CONCLUSION

There was no correlation between the circumferential degree or thickness of cavernous artery calcification and the presence of MCA and/or non-MCA infarction or noninfarction. The cavernous carotid artery calcification score is not different between patients with strokes and without strokes.

KEY WORDS: Middle cerebral artery infarction, cavernous carotid artery, calcification

Paper 69 Starting at 4:20 PM, Ending at 4:28 PM**Virchow Robin Space Dilatation Is a Sensitive Indicator of Microvascular Disease: A Study in Elderly Patients with Depression and Dementia**

Patankar, T. A. F. • Baldwin, R. • Varma, A. • Jeffries, S. • Neary, D. • Burns, A. • Jackson, A.

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Manchester, UNITED KINGDOM

PURPOSE

Our aim was to test the hypothesis that dilation of Virchow Robin spaces (VRS) can act as a surrogate marker for microvascular disease and is associated with subcortical vascular dementia and with treatment resistance in elderly depressed individuals.

MATERIALS & METHODS

Fifty patients with late-onset major depressive disorder (29 who were responders to antidepressant monotherapy (Res) and 21 who were nonresponders (NRes), 75 consecutive patients with dementia (vascular dementia (VaD; n = 24), Alzheimer's disease (AD; n = 35) and frontotemporal dementia (FTD; n = 16) and 35 normal volunteers (Norm) were recruited. Imaging included: 1) fluid attenuated inversion recovery (FLAIR); 2) T1-weighted inversion recovery (IR) and 3) variable echo, fast spin-echo (VE) images. Assessment of deep white matter and periventricular hyperintensities was performed on matched IR and FLAIR images (1, 2). Virchow Robin spaces were scored separately in the centrum semiovale, mesencephalon and the subinsular region. Virchow Robin spaces in the basal ganglia were scored using two separate scoring schemes, the first of these reflects the anatomical distribution of basal ganglia VRS (BG1) and the second reflects both the distribution and number (BG2). Statistical analysis was performed to identify differences between groups, diagnostic specificity, and relative diagnostic power.

RESULTS

The BG2 score was significantly different between the Res, NRes, and normal groups ($p < 0.001$). Pairwise *a posteriori* comparisons demonstrated significantly higher values in the NRes than in the Res ($p < 0.01$) or normal volunteer groups ($p < 0.001$). In a multiple regression analysis BG2 VRS score accounted for 38% of the variance in the regression model and Schelten's PVH score acted as an independent predictive factor accounting for an additional 6%. In the dementia group (AD, FTD, VaD, Norm) Schelten's PVH, basal ganglia hyperintensity and overall score were significantly greater in patients with VaD than in AD or normals ($p < 0.01$). The basal ganglia scores BG1 and BG2 were significantly higher in vascular dementia than in normal volunteers ($p < 0.005$ and $p < 0.001$ respectively), patients with AD ($p < 0.001$) or patients with FTD ($p < 0.01$). Centrum semiovale VRS were significantly more frequent in patients with FTD than in normals ($p < 0.01$). Multiple regression analysis in the dementia group showed that the BG2 VRS score acted as an independent predictive factor accounting for 29% of the variance in the regression model, the centrum semiovale VRS score accounted for a further 9% and the Schelten's PVH score accounted for only 2%.

CONCLUSION

Our studies show that scores of VRS dilatation in diseases with cerebral microvascular abnormalities have diagnostic specificity which is more specific than that provided by the distribution and nature of T2-weighted abnormalities.

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KEY WORDS: Virchow Robin spaces, dementia, depression

Monday Afternoon

3:00 PM - 4:30 PM
Room 606 - 609

(12c) Head & Neck: General
(Scientific Papers 70 - 80)

See also Parallel Sessions

(12a) Adult Brain: Neoplasms

(12b) Adult Brain: Cerebrovascular Disease and Stroke

(12d) Pediatrics: General and Developmental and Congenital Disorders

Moderators: Laurie A. Loevner, MD
Suresh K. Mukherji, MD

Paper 70 Starting at 3:00 PM, Ending at 3:08 PM **CT-Guided Aspirations: The First 200 Assessments**

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¹Johns Hopkins Hospital, Baltimore, MD, ²University of Pennsylvania Medical Center, Philadelphia, PA

PURPOSE

To determine the reliability of CT-guided aspiration over an experience of 216 consecutive cases performed.

MATERIALS & METHODS

The histopathologic findings and CT-guided procedure notes from 216 consecutive head and neck fine needle aspirations (FNAs) performed by one radiologist from 1993 to 2003 were reviewed retrospectively. The types of needles used, number of passes required, location of the lesion, initial cytologic diagnosis, and final histopathologic diagnosis or final clinical diagnosis were reviewed retrospectively.

RESULTS

A diagnostic sample was obtained in 195/216 (90.3%) of the lesions with 21 (9.7%) inadequate samples. A correct diagnosis was made in 191/216 cases (88.4%). Inaccurate samples in which the final diagnosis was discordant with the fine needle aspiration were present in 4/216 (1.9%) of the specimens, with the parapharyngeal space and parotid gland having the highest rate. The range in number of passes required to make a final diagnosis was one to six, with a mean of 2.6 passes per specimen (SD 1.13) and a median of 2.0.

Diagnosis	PPS	Accuracy of CT-guided FNA				Total
		Thyroid	Parotid	Paraspinal	Other	
Correct	23 (85%)	49 (92%)	29 (81%)	25 (100%)	65 (87%)	191
Non-DX	3 (11%)	4 (8%)	6 (17%)	0	8 (11%)	21
Wrong DX	1 (4%)	0	1 (2%)	0	2 (2%)	4
Total	27	53	36	25	75	216

CONCLUSION

CT-guided FNA is a safe, well-tolerated, and accurate tool in diagnosis of head and neck lesions. Our series demonstrates an improvement in the percent of diagnostic samples obtained when compared with prior reports and an overall low diagnostic error rate, possibly related to on-site evaluation by the cytopathologist and improved FNA technique.

KEY WORDS: Fine needle aspiration, CT guidance, head and neck

Paper 71 Starting at 3:08 PM, Ending at 3:16 PM

Open MR Image-Guided Injection of the Anterior Scalene Muscle for Thoracic Outlet Syndrome: Technique, Complications, and Results

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PURPOSE

Thoracic outlet syndrome (TOS) may arise from compression of the roots of the brachial plexus between the anterior and middle scalene muscles (1). Muscle fiber structural changes from prolonged contraction can occur in the anterior scalene muscle (ASM) (2, 3). Anterior scalene muscle anesthetic blocks may predict which patients may benefit from surgical decompression and usually are performed using surface landmarks, electrophysiologic guidance (4) or CT. MR imaging has advantages including real-time guidance for needle placement and injectate distribution and avoiding critical structures.

MATERIALS & METHODS

Over the past 4 months, 12 adult subjects (7 F/5M) with the clinical diagnosis of TOS were referred for ASM injection under open MR imaging guidance (Siemens Viva). The patient was positioned supine, with the inferior neck in the isocenter with a belt coil (Siemens MP35 s). Axial T1-SE was used to identify the ASM, typically at the C7 level, and to plan a near horizontal needle (Lufkin 22 G/10 cm) trajectory to maximize needle identification based on susceptibility. Insertion was performed parallel to a series of 8 mm thick, 3 slice axial FLASH (90 TR, 7.4 TE, 40 flip, 40 FOV, 96 x 256 matrix, 20 secs) sections. The midportion of the muscle was targeted, avoiding external jugular veins, carotid and interscalene space, pulmonary apex, vertebral artery, and

sympathetic chain. Marcaine (0.5%, 4-6 cc) and Kenalog (40 mgs) were injected, which is hypointense, and can be followed readily during placement, adjusting the needle tip to ensure muscle infiltration and reduce extravasations. Follow-up T2 SE was used to document injectate position. Total procedural time is ≤ 45 minutes.

RESULTS

In all instances, there was successful introduction of injectate into the ASM. On T2 SE images, the hyperintense intramuscular injectate was noted to infiltrate the ASM as follows: 100% replacement (1 case), 75-80% (4), 50-70% (4). In 3, the injectate infiltrated the central 75% of the muscle, dividing the uninjected areas into medial and lateral portions. Mild extravasations were noted in the majority of cases, predominately lateral to the ASM, with medial extension in 5 cases and posterior in 2 cases. Postprocedure arm weakness/numbness was noted to be mild in 6, moderate in 1, and there was transient nausea in 2, all symptoms resolved within 24 hours. There was no evidence of Horner sign, or other complications.

CONCLUSION

Open MR imaging is a rapid, accurate modality to perform ASM injections, with low transient complications. Of importance is its ability to evaluate its success of intramuscular placement. Operator skill is required. Additional procedures such as middle scalene injection and/or botulinum chemodenevation also can be performed during the same setting.

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KEY WORDS: Thoracic outlet syndrome, interventional MR imaging, scalene block

Paper 72 Starting at 3:16 PM, Ending at 3:24 PM

CT Perfusion in Head and Neck Cancer: A Pilot Study

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PURPOSE

This study was performed to evaluate the feasibility, reproducibility, and reliability of perfusion computerized tomography (CTP) in the head and neck (H&N) following a regular enhanced CT, and to attempt to differentiate benign from malignant processes.

MATERIALS & METHODS

Perfusion computerized tomography was attempted on 15 patients 5 minutes after regular H&N contrast-enhanced CT (CECT), with injection of 40 ccs of contrast at 4 cc/sec. The regions of interest, based on CECT, were scanned with four consecutive 5 mm thick CT images every second for 50 sec-

onds. The data was postprocessed using a commercial vendor software package utilizing a deconvolution-based technique. Internal carotid artery (ICA) and, where possible, external carotid artery (ECA) were used as arterial input vessels and the internal jugular vein as the venous output vessel. The data were processed into maps for each arterial input that represented blood volume (BV) (mL/100 g), blood flow (BF) (mL/100 g x min), mean transit time (MTT) (sec), and capillary permeability surface product (CP) (mL/100 g x min). Two observers independently performed all the steps and obtained ROIs through the primary site (PS), salivary glands (SG), thyroid gland, paraspinal muscles (PSM), muscles of mastication, sternocleidomastoid muscle, base of tongue (TB), and subcutaneous fat (SQ). The different repeated measurements were compared using ANOVA test. Histologic specimens of all lesions were obtained.

RESULTS

One case was excluded due to poor bolus timing. Three cases were excluded due to extensive laryngeal motion. Of the remaining 11 cases 5 had cancer, 3 had benign lesions, and 3 had no evidence of the clinically suspected cancer.

The study revealed no significant interobserver difference, the lowest p value was 0.13 for the parotid gland, and the highest was 0.81 for the PSM, and for the PS it was 0.35. The study also failed to reveal significant difference between CTP with ICA vs ECA arterial input with the lowest p value of 0.45 for the parotid gland and the highest 0.89 for the PSM and it was 0.57 for the PS. Measurements obtained for the SQ and TB were extremely variable and excluded. As seen in the Table muscles maintain low BV, BF, and CP values but have a long MTT. The thyroid and SGs demonstrate high BV, BF, and CP and have a low MTT. Differentiation between malignant and nonmalignant lesions was most reliable with MTT. The measurements obtained were comparable to the values in the literature.

	Mean/standard deviation			
	BF	BV	MTT	CP
Thyroid	137.28/39.46	14.95/3.62	7.38/1.79	24.25/7.44
Masseter	14.65/14.38	1.49/0.37	16.1/8.78	9/4.67
PSM	4.74/2.65	1.13/0.63	20.82/6.85	6.46/5.30
Sternocleidomastoid	16.39/10.05	1.41/0.73	10.63/5.1	5.35/4.03
SG	62.41/50.15	4.11/1.68	6.26/2.68	34.86/10.11
Malignant lesions	80.93/47.94	3.97/2.02	3.74/1.11	21.9/6.66
Benign lesions	30.4/3.61	3.3/0.32	9.4/2.12	29.67/11.88

CONCLUSION

Perfusion computerized tomography in the H&N is feasible except at laryngeal level. Perfusion computerized tomography performed after regular enhanced CT of the H&N using ICA for the arterial input provides reliable and reproducible results that are not observer dependent. Perfusion computerized tomography shows promise in distinguishing benign and malignant processes, primarily by MTT, while some overlap exists between malignant lesions, salivary and thyroid glands.

KEY WORDS: CT perfusion, cancer, feasibility

Paper 73 Starting at 3:24 PM, Ending at 3:32 PM**Diagnostic Accuracy of CT Angiography for Traumatic or Atherosclerotic Lesions of the Carotid and Vertebral Arteries: A Systematic Review**

Hollingworth, W. • Nathens, A. B. • Kanne, J. P. • Crandall, M. L. • Crummy, T. A. • Hallam, D. K. • Wang, M. C. • Jarvik, J. G.

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PURPOSE

Helical CT angiography (CTA) has become an established technique for evaluating atherosclerosis of the cerebrovascular arteries. However, the role of CTA in penetrating and blunt trauma to the carotid and vertebral arteries is not well defined. We conducted a systematic literature review to determine the diagnostic accuracy of CTA for atherosclerotic, penetrating and blunt lesions in the carotid and vertebral arteries.

MATERIALS & METHODS

We searched MEDLINE and EMBASE data bases to identify studies evaluating the diagnostic accuracy of CTA of the carotid and vertebral arteries published between January 1 1992 and December 31 2002. Two reviewers independently assessed abstracts and full text to determine study eligibility. Studies were included if they met the following criteria: (1) primary data on humans, (2) more than ten subjects, (3) evaluates the diagnostic accuracy of CTA, (4) images the carotid or vertebral arteries, (5) uses conventional angiography or surgical findings as the reference standard, (6) not a study of nontraumatic aneurysm or tumor. Information on methodologic quality, imaging technique, and diagnostic accuracy was abstracted from all eligible studies by three independent reviewers. We pooled sensitivity and specificity data from diagnostic accuracy studies of high methodologic quality.

RESULTS

Forty-three articles met the inclusion criteria and were included in the review. Thirty studies examined atherosclerotic disease, two blunt trauma, two penetrating trauma, and nine examined patients with other pathology. Pooled data from 15 higher quality studies demonstrated that CTA had a sensitivity of 95% [91% to 97%; 95% confidence interval (CI)] for detecting severe (> 70%) atherosclerotic stenosis of the carotid artery. The specificity of CTA for severe stenosis was also high 98% (96% to 99%; CI). CT angiography remained a sensitive technique (95%; 93% to 97% CI) when the criterion for a positive result is relaxed to moderate or greater (> 30%) stenosis. The two studies raised concerns about the use of CTA in the blunt trauma setting suggesting that CTA may not be sensitive for detecting small intimal injuries (sensitivity < 70%). However, the results from these two studies were heterogeneous and both studies used older technologies for either obtaining or viewing images. Conversely, two penetrating trauma studies concluded that the sensitivity of CTA was high.

CONCLUSION

Our findings demonstrate that CTA is both a sensitive and specific imaging technique for identifying severe atherosclerotic stenosis and occlusion of the carotid arteries. However, there currently is not enough high quality evidence to accurately estimate the sensitivity and specificity of CTA in the setting of blunt or penetrating trauma. Further studies capitalizing on newer imaging technology (for example multidetector CT) and better viewing techniques (for example PACS) are required to validate the use of CTA in the setting of trauma.

KEY WORDS: CT, carotid arteries, meta analysis

Paper 74 Starting at 3:32 PM, Ending at 3:40 PM**Do We Need to Inject More Than 60 ccs of Contrast for Neck CT Angiography with an Automated Trigger Technique?**

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PURPOSE

To determine the reliability of low-dose contrast neck CT angiography (CTA) by measuring the Hounsfield units (HU) in the vessels, assessing the degree of venous contamination, and evaluating the adequacy of the image quality.

MATERIALS & METHODS

Two neuroradiologists retrospectively reviewed the images of 20 patients (11 female, 9 male, ages 9-82 years) who underwent low-dose contrast neck CTA (60 cc Iohexol 350 iv [predominantly antecubital vein], injection rate 3-4 cc/sec; the exception was a 9 year old who received a 40 cc [1 cc/kg] dose). Images were acquired on a 16 multislice Toshiba Aquilion scanner from the aortic arch to the suprasellar cistern at 1 mm collimation, a pitch factor of just less than 1 (15/16), and a scan time of 11-14 seconds. A region of interest (ROI) was placed on the aortic arch with trigger point set between 140-160 HU. Three-dimensional processing was done on a Vitrea (Vital Images, Plymouth, MN) workstation. HUs were measured at the aorta, just below the common carotid artery (CCA) bifurcation, at the internal carotid artery (ICA) terminus, and at the mid basilar artery (BA). Venous contamination was graded as complete if neck veins were opacified fully on the volume rendered images; partial when veins overlying the CCA bifurcations were just opacified; and absent when the CCA bifurcations were visualized clearly without changing the preset windows. Image quality was assessed subjectively as diagnostic or nondiagnostic.

RESULTS

All scans were of diagnostic quality. In no case was a repeat CTA exam or diagnostic angiogram required. Venous contamination was absent in 10/20 (50%) cases; partial in 8/20 (40%) cases; and complete in 2/20 (10%) cases. We determined that 250 HUs or higher within the vessels is desired for high quality CTA. The range of HUs was as follows: 1) Arch, 170-352 HU; 2) CCA, 208-639 HU; 3) ICA terminus, 175-480 HU; and 4) basilar artery, 179-469 HU. In 14/20 (70%) cases there was an expected rise in HUs after automated trigger scan initiation and persistent HU measurements above 250 in the distal ICAs and basilar artery. In the

remaining 6/20 (30%) of cases there was an initial increase in HUs in the CCAs followed by a decrease in HUs in the ICAs and BA, with the total dropping below the desired level of 250 HU (lowest was 175 HU). Though the images were of adequate quality to interpret, the 3D volume rendered images were mildly degraded.

CONCLUSION

Our neck CTA protocol provides the clinical benefit of decreased dose of iodinated contrast with diminished chance of contrast-related complications such as nephrotoxicity and is more economical. When the automatic trigger is performed properly, injection of more than 60 ccs of contrast is not necessary as excess contrast may still be in the arm, lungs, and heart and noncontributory towards the angiogram. However, in patients with poor cardiac output, those requiring longer scan time due to larger area of coverage, or iv access more distal to the antecubital vein, it may be necessary to increase the dose of contrast to 80-90 ccs.

KEY WORDS: CT angiography, neck CTA, low-dose contrast

Paper 75 Starting at 3:40 PM, Ending at 3:48 PM

Optic Neuritis Secondary to Cat Scratch Disease: Distinguishing MR Imaging Features to Other Types of Optic Neuropathies

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PURPOSE

MR imaging characteristics of optic neuritis caused by cat scratch disease (CSD) have not been described yet. However, such knowledge may guide laboratory evaluation, prevent incorrect diagnosis, and contribute to the immediate initiation of appropriate antibiotic therapy. Therefore, the purpose of this study was to establish MR features distinguishing optic neuritis secondary to CSD from other types of optic neuropathies.

MATERIALS & METHODS

All patients (n = 98) who presented to the University of Florida Eye Clinic with signs and symptoms of an optic neuropathy between April 1997 and March 2003 and had an MR examination available for review were included in this retrospective study. Two readers (one neuroradiologist and one neuroophthalmologist) reviewed the MR images independently in regards to presence, location, and extent of optic nerve enhancement. In addition, presence and extent of cerebral white matter lesions was recorded. Correlation of the MR findings to the final diagnosis was made.

RESULTS

Nine percent (9/98) of the patients received the final diagnosis of CSD. Forty percent (38/98) of all patients demonstrated enhancement of one or both optic nerves. None of the patients with CSD showed bilateral optic nerve enhancement. In comparison, bilateral enhancement was seen in 21% (7/33) of the other patients. The optic nerve enhancement in CSD patients (5/38) was localized to a 3-4 mm segment at the optic nerve-globe junction. All other optic neuritis patients (32/38) with one exception showed enhancement away from the optic nerve junction or a long segment

enhancement when the optic nerve globe junction also was involved. None of the patients with optic neuritis due to CSD demonstrated cerebral white matter lesions. Four of the patients with final diagnosis of CSD did not show any optic nerve MR abnormalities. Therefore, the specificity of the MR findings for CSD was 83.3% and the sensitivity 55.6%.



CONCLUSION

Unilateral, short segment enhancement at the optic nerve-globe junction is highly specific for CSD as underlying cause of optic neuritis and should initiate confirmatory laboratory testing for *Bartonella henselae*, the causative organism of CSD. However, the lack of optic nerve enhancement does not exclude the possibility of optic neuritis caused by CSD as reflected in the low sensitivity value.

KEY WORDS: Cat scratch disease, optic neuropathy, MR imaging

Paper 76 Starting at 3:48 PM, Ending at 3:56 PM

Difficulty in Defining Lymphatic Extension to Supraclavicular Fossa for Staging of Nasopharyngeal Carcinoma by MR Imaging

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PURPOSE

The UICC Staging System (5th edition) for nasopharyngeal carcinoma (NPC) includes lymphatic extension to supraclavicular fossa (SCF) as one of the staging criteria for N3 disease. While clinicians have little difficulty in recognizing the demarcating boundaries, radiologists cannot easily mark the boundary that stretches from the sternal end of the clavicle to the point where the neck meets the shoulder. Som et al. (1999) hence recommended that the visualized portion of the clavicle, as seen on each of the axial images, be used as the imaging marker for the SCF. To assess the accuracy of this radiologic landmark in correlating with clinically palpable nodes in SCF.

MATERIALS & METHODS

Among the newly diagnosed NPC patients investigated with MR in our hospital during 2000 to 2002, 21 patients had palpable SCF nodes detected/ confirmed by experienced oncologists. All patients were scanned from the base of skull to the inferior border of clavicles using 1.5 T MR (Symphony, Siemens Medical Systems). Their axial films (including postgadolinium T1 weighted images with fat saturation) were reviewed by two qualified radiologists.

RESULTS

The median time interval between clinical examination and MR was 16 days (range: 7-25). Of the 21 patients with clinically palpable SCF nodes, 15 (71%) did not show any lymphadenopathy in the SCF defined radiologically with the clavicle as the landmark. Only 4 (19%) patients showed definite extension both clinically and radiologically, while 2 (10%) were equivocal.

CONCLUSION

Radiologic demarcation of SCF is difficult and the landmark currently recommended by Som et al. might under-stage substantial proportion of patients with clinical N3 disease. A more accurate way for MR delineation of SCF should be explored.

KEY WORDS: Supraclavicular fossa lymphadenopathy, radiologic landmark, under-stage

Paper 77 Starting at 3:56 PM, Ending at 4:04 PM

Parapharyngeal Masses: The Value of Dynamic Contrast-Enhanced MR in Predicting their Histology

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PURPOSE

To determine the utility of dynamic contrast-enhanced MR imaging compared to conventional MR imaging in the evaluation of parapharyngeal masses and whether it is predictive of their histology.

MATERIALS & METHODS

We retrospectively examined MR imaging studies obtained at our institution over the past 6 years on patients with parapharyngeal masses (8 glomus tumors, 5 schwannomas, 7 pleomorphic adenomas, 6 metastatic lymph nodes, and 8 reactive lymph nodes). When possible, pathologic and/or surgical confirmation of the diagnosis was accomplished. The MR imaging protocol included axial T1-weighted SE, axial STIR, dynamic contrast-enhanced FMPSPGR with fat saturation, and equilibrium contrast-enhanced SE with fat saturation sequences. Relative contrast enhancement was calculated objectively as a ratio of the absolute signal intensity of the lesion to that of normal muscle.

RESULTS

Glomus tumors showed two different behaviors, one with intermediate-to-high signal intensity on T2-weighted images, characteristic flow voids, and early intense enhancement after administration of contrast, with some washout but overall intense persistence of enhancement. The other group showed uniformly high signal on T2-weighted images and

early intense enhancement but with progressive washout of the contrast. Schwannomas and pleomorphic adenomas showed a similar pattern of early moderate heterogeneous enhancement with a gradual intense increase over time. However, the schwannomas had very high signal intensity on T2-weighted images, while the pleomorphic adenomas had a much lower signal intensity. Metastatic and reactive lymph nodes were indistinguishable, demonstrating high signal on T2-weighted images and early modest diffuse enhancement with a gradual intense increase.

CONCLUSION

Dynamic gadolinium-enhanced MR imaging is superior to conventional MR imaging in the evaluation of parapharyngeal masses and may be predictive of their histology.

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KEY WORDS: Parapharyngeal space, glomus tumor, dynamic contrast-enhanced MR imaging

Paper 78 Starting at 4:04 PM, Ending at 4:12 PM

Assessment of Salivary Gland Function of Nasopharyngeal Carcinoma Patients Receiving Radiotherapy by Using Dynamic Contrast-Enhanced MR Imaging and Pharmacokinetic Analysis

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PURPOSE

Radiotherapy is the main treatment for nasopharyngeal carcinoma (NPC). The price to be paid for this effective treatment is universal xerostomia. Salivary glands have been proved to be extremely radiosensitive. We try to develop an objective measurement for evaluating the salivary gland function as correlated with the fluctuation of saliva amount during treatment.

MATERIALS & METHODS

Twenty patients with newly diagnosed NPC and no previous treatment were studied by MR imaging. The anatomical images included high-resolution T1-weighted, fat-saturated fast spin-echo T2-weighted, and contrast-enhanced T1-weighted images. The dynamic contrast-enhanced MR imaging was performed by using a 2D fast spoiled-gradient recalled sequence with single dose bolus injection of contrast agent. Calculated values included time to peak, peak enhancement, maximum slope, and washout slope for the enhancement. The designed pharmacokinetic parameters were employed also in this study. All patients underwent radiotherapy as part of treatment protocol and the imaging results were correlated with the data of saliva collection.

RESULTS

Dynamic contrast-enhanced MR imaging and saliva amount comparisons were obtained. After radiotherapy, the salivary gland, especially the parotid gland, has a longer time to peak, reduced peak enhancement, reduced maximum slope, and slower washout slope. Our data, assisted by pharmacokinetic analysis, are consistent with decreased transfer of contrast agent to tissue and reduced volume of the extravascular extracellular space that had been radiated.

CONCLUSION

Analysis of dynamic contrast-enhanced MR imaging can differentiate normal from radiated salivary gland tissue in NPC patients. The correlation with clinical decreased saliva amount also is fairly good.

KEY WORDS: Salivary gland, MR imaging, nasopharyngeal carcinoma

Paper 79 Starting at 4:12 PM, Ending at 4:20 PM**Expanding the Role of Multislice CT: Do the Three-Dimensional Multiplanar Reformats of the Neck Give Additional Information?**

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PURPOSE

To retrospectively compare routine interpretation of the neck CT on axial images with the findings after the evaluation on three-dimensional (3D) multiplanar workstation.

MATERIALS & METHODS

The study includes 17 patients who underwent neck CT for various indications. These exams were interpreted already only on the 3 mm thick axial images by different staff neuroradiologists. The neck CTs were acquired at 1.00 mm reconstruction with 50% overlap. Except one, all received 90-100 ccs of iodinated contrast intravenously. The data then were reevaluated by two neuroradiologists on 3D Vitrea workstation (Vital Images, Plymouth, MN) using multiplanar reformats, curved reformats, and other 3D rendering techniques.

RESULTS

The additional findings after 3D interpretations of the images were divided into three categories: 1. That would change the clinical management; 2. That may or may not change the clinical management; 3. Additional findings of little or no clinical significance. Two patients had category one findings, which were clinically significant: one with right palatine swelling and other lingual tonsillar mass. Seven patients had category two findings: one vocal cord paralysis, extent of the tongue carcinoma in two patients, tracheal narrowing in two patients, eccentric thickening of the epiglottis in a patient with treated carcinoma and extent of neck lymphadenopathy in one. In rest of the 8 patients, there was no significant additional information.

CONCLUSION

While the role of the 3D reformats is well established in the cervical spine CT and the CT angiography, it has not been explored fully in the routine neck CT interpretations. Eyes

are prone to overlook any gradual change in a structure or mass if the images are scrolled one by one; however, if the same data are reconstructed in 3D, we get an overall view of the structure or the lesion much better. Newer generation CT scanners provide volume data that can be used for 3D multiplanar reformat. There are several structures in the neck, which ideally should be looked at in multiple planes for complete evaluation. The airway including vocal cords, tongue, cranio-caudal dimension and level of the lymph nodes, cranio-caudal dimension of the masses, vascular deviations, prevertebral and retropharyngeal spaces are better appreciated when seen in the entirety. Thinner slices also make it possible to get very good quality 3D reformats.

KEY WORDS: Multislice CT, neck, 3D reformats

Paper 80 Starting at 4:20 PM, Ending at 4:25 PM**Imaging Findings in a Patient with Intraorbital Extramedullary Hematopoiesis**

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PURPOSE

To describe the imaging findings in a patient with intraorbital extramedullary hematopoiesis.

MATERIALS & METHODS

A 69-year-old female presented with 1-month history of bilateral orbital pain, progressive swelling, redness, blurry vision, and photophobia. Past medical history was significant for long-standing myelofibrosis with myeloid metaplasia. Physical exam revealed marked bilateral periorbital swelling with conjunctival erythema and photophobia. The extraocular movements and vision were intact.

RESULTS

MR examination of the head revealed bilateral intraconal masses that partially encased the optic nerves. They demonstrated low T1, high T2 signal intensity and intense enhancement with gadolinium. There was mild proptosis. There was also diffuse low T1 signal marrow abnormality. Given these findings, extramedullary hematopoiesis was suggested, which was confirmed with Tc99 sulfur colloid scan.

CONCLUSION

Nervous system involvement by extramedullary hematopoiesis is uncommon and presents as T2 shortening and intense gadolinium enhancement. Most common CNS sites of extramedullary hematopoiesis include dura matter (along cerebral convexities, falx cerebri, and epidural space of the spinal canal) and choroid plexus (1). Paraspinal soft tissues also can be involved with extension through the neural foramina into the spinal canal. Intraorbital involvement is rare, with only one case report of MR findings in intraorbital extramedullary hematopoiesis found in our review of the literature (2).

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KEY WORDS: Extramedullary hematopoiesis, orbital, myelofibrosis

Monday Afternoon

3:00 PM - 4:30 PM

Room 611 - 612

(12d) Pediatrics: General and Developmental and Congenital Disorders

(Scientific Papers 82 - 93)

See also Parallel Sessions

(12a) Adult Brain: Neoplasms

(12b) Adult Brain: Cerebrovascular Disease and Stroke

(12c) Head & Neck: General

Moderators: Bernadette L. Koch, MD
Thomas P. Naidich, MD

Paper 82 Starting at 3:00 PM, Ending at 3:08 PM

Mitochondrial Disorders: Variability of Imaging Findings and Evolution over Time

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PURPOSE

To describe the spectrum of neuroimaging findings and their evolution over time in children with mitochondrial disorders.

MATERIALS & METHODS

Brain MR images were obtained of 70 children with mitochondrial disorders. Age at onset, sex, blood or CSF lactate levels and pyruvate levels and clinical course were known in all cases. Diagnostic muscle biopsy was performed for mitochondrial DNA studies with isolation of mitochondria for

electron transport chain enzyme assay in the majority. Diagnoses included pyruvate dehydrogenase deficiency (PDH), cytochrome oxidase deficiency (COX), complex I deficiency, T8993G mutation causing neuropathy, ataxia, and retinitis pigmentosa (NARP), Kearns-Sayre syndrome and mitochondrial encephalopathy with lactic acidosis and stroke-like episodes (MELAS). Sequential MR studies were obtained in 25 of the children. Degree of atrophy and T2 signal abnormality within specific brain structures were graded from 0, no involvement to 3, severe depending on the proportion of the structure involved.

RESULTS

Although patients frequently demonstrated symmetric abnormal signal intensity in the caudate, putamen, midbrain and brainstem as classically described in mitochondrial disorders, the distribution of brain MR changes was variable within the series. Variations included sparing of basal ganglia with marked infratentorial involvement, predominant white matter or cortical involvement and marked asymmetry of signal abnormalities. Patients with NARP demonstrated significant brainstem and cortical atrophy. Sequential studies showed striking variability of imaging findings over time, even in children with the same biochemical defect. Temporal changes ranged from localized lesions which remained static over years to rapidly progressive lesions involving extensive areas of brain within months. Disappearance of high T2 signal intensity often was followed by atrophy in involved structures but progressive atrophy occurred in the absence of T2 changes. Appearance and disappearance of T2 signal abnormalities was a common finding and frequently occurred rapidly.

CONCLUSION

A wide variation of imaging findings may be seen in patients with mitochondrial disorders. Serial brain MR imaging may be necessary to identify a neurodegenerative picture suggestive of these diseases.

KEY WORDS: Mitochondrial disorders, pediatric brain, MR imaging

Paper 83 Starting at 3:08 PM, Ending at 3:16 PM

MR Assessment of Pre and Postnatal Posterior Fossa Morphology and Correlation with Clinical Signs of the Chiari II Malformation in Children Undergoing In Utero Myelomeningocele Repair

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PURPOSE

Compare posterior fossa morphology on fetal MR prior to in utero myelomeningocele (MMC) repair with serial postnatal MR and correlate the findings with clinical signs of the Chiari II malformation.

MATERIALS & METHODS

Posterior fossa morphology was evaluated with MR in 33 fetuses (19 to 26 weeks gestation) with MMC and Chiari II malformation, using the following scale: Grade 1 - visualization of 4th ventricle and cisterna magna (CM), Grade 2 -

visualization of 4th ventricle or CM, Grade 3 - no 4th ventricle or CM visualized. Postnatal MR examinations (ages: 28 weeks to 3 years) were evaluated for cervicomedullary kinking (none, mild, moderate), presence or absence of tectal beaking, and cerebellar herniation (in mm). Postnatal follow-up MR imaging at greater than or equal to 1 year of age was available in 24 patients. Pre and postnatal MR findings were correlated with signs of Chiari II malformation, including need for ventricular shunting, stridor, apnea, strabismus, and feeding difficulties.

RESULTS

On fetal MR, hindbrain herniation was present in all patients. Three patients were grade 1, 12 patients were grade 2, and 18 patients were grade 3. Following in utero MMC repair, significantly improved cerebellar herniation was seen in 84.8% (28/33) of patients. At 1 year of age, worsening cerebellar herniation was present relative to immediate postnatal scan in 50% (12/24) of patients. Cervicomedullary kinking improved, but tectal beaking remained present in 93.9% (31/33) of patients. Fifty-one and one-half percent (17/33) of patients required ventricular shunting. Of these, 58.8% (10/17) had greater than 1 mm of residual cerebellar herniation on initial postnatal MR imaging. Fifty percent (6/12) of patients with increasing cerebellar herniation on postnatal follow-up scans required shunting. Twelve and one-tenth percent (4/33) of patients had clinical signs referable to Chiari II malformation. Of these patients, 75% (3/4) had greater than 1 mm of cerebellar herniation on postnatal follow-up. Seventy-five percent (3/4) of symptomatic patients required shunting.

CONCLUSION

Following in utero MMC repair, there is significant improvement in cerebellar herniation. Tectal beaking remains present in the majority of patients while cervicomedullary kinking resolves. At 1 year of age, progressive cerebellar herniation may be seen. Patients with residual or increasing herniation were more likely to require ventricular shunting. In patients with signs referable to Chiari II malformation, the majority will have residual cerebellar herniation and require shunting. Correlation with imaging of the spine is planned to assess for interval retethering of the spinal cord as the etiology of the progressive herniation.

KEY WORDS: Pediatric, Chiari II malformation, fetal MR imaging

Paper 84 Starting at 3:16 PM, Ending at 3:24 PM

Limited Dorsal Myeloschisis: MR Findings with Embryologic Correlation

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PURPOSE

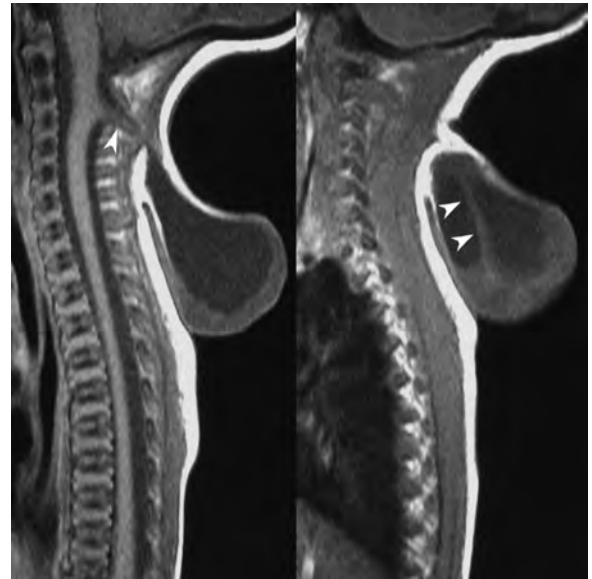
To present the MR findings of limited dorsal myeloschisis (LDM) and to discuss the embryologic substratum of this rare subset of closed spinal dysraphisms.

MATERIALS & METHODS

There were three newborns with large, sessile, midline posterior masses located at cervical, thoracic, and thoracolumbar level, respectively. The dome of the mass was covered by thickened, dystrophic epithelium, whereas the base and lateral walls were covered by intact skin. All newborns were neurologically intact. MR imaging of the whole neuraxis was performed prior to surgical repair.

RESULTS

In all cases, MR imaging showed a thin stalk emanating from the dorsal aspect of an otherwise normal spinal cord, crossing a narrow posterior bony spina bifida, and fanning out into a posterior meningocele to connect to the inner aspect of the dome. Dilatation of the ependymal canal just cranial to the origin of the posterior stalk was detected in one case. A Chiari II malformation was associated in one case.



CONCLUSION

Closed spinal dysraphisms with subcutaneous mass occurring at cervicothoracic level are exceedingly rare, and are significantly different from those occurring at lumbosacral level. They are characterized by a large skin-covered meningocele crossed by a fibroneurovascular stalk that attaches to the dome of the meningocele (so-called skin-covered myelomeningocele). Rarely, a hydromyelic cavity that is continuous with the ependymal canal dissects the stalk (i.e., nonterminal myelocystocele). These lesions are better defined embryologically as variants of an LDM spectrum. The pathogenesis is represented by localized failure of the final fusion of the apposed neural folds after most of neurulation has been completed. Limited, incomplete fusion of the dorsal neural folds results in failed separation of the cutaneous from the neural ectoderm. This results in a fibroneurovascular stalk emanating from the dorsal aspect of the spinal cord and penetrating through a narrow dorsal dural opening into the posterior meningocele, to eventually connect to the skin. Because the extent of the myeloschisis is minimal, formation of the superficial tissues is not prevented, resulting in a skin-covered malformation. In our opinion, the denomination "myelomeningocele" is not completely satisfactory on account of the striking differences from lumbosacral myelomeningoceles (i.e., the presence of a skin coverage to the malformation and the fact that affected newborns are significantly less impaired than those with classi-

cal myelomeningoceles). Moreover, the Chiari II malformation is present in only a minority of cases, perhaps because the limited extent of the myeloschisis makes it less likely for enough CSF hypotension to occur within the developing neural tube. MR imaging is crucial to identify the various components of the malformation and to plan surgical repair.

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KEY WORDS: Spinal dysraphism, myelomeningocele, myelocystocele

Paper 85 Starting at 3:24 PM, Ending at 3:32 PM

Appearance of the Germinal Matrix and Developing Neocortex on Postmortem MR Imaging

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PURPOSE

Developmental abnormalities of cortical formation are common findings in pediatric neuroradiology. The cortex is formed by the passage of neurons and glia from the periventricular germinal matrices to the future cortex. Postmortem MR imaging provides an opportunity to study the fetal germinal matrix at different gestational ages in fetuses with normal brains as well as fetuses with brain malformations. In this paper we present our experience of imaging the fetal germinal matrix postmortem.

MATERIALS & METHODS

Postmortem fetal imaging has been performed as a research study in Sheffield with approval from the local ethics committee. So far 180 procedures have been performed, the vast majority having some form of abnormality. In this report we describe the size and appearance of the germinal matrix in 15 fetuses with no demonstrable brain or somatic abnormalities on autopsy. All fetal brains were imaged in situ on a 1.5 T superconducting system (Eclipse, Philips Medical Systems) using either a knee or ankle coil depending on the size of the fetal head. High-resolution FSE T2-weighted images were taken in the three orthogonal planes. The area of the germinal matrices and the hemispheric thickness was measured on anatomically consistent regions on the coronal images in all cases. Those values were correlated with gestational age measured after the last menstrual period.

RESULTS

The germinal matrix is demonstrated easily on the T2-weighted images as it shows marked T2 shortening when compared to the adjacent brain. The thickness of the hemisphere showed positive linear correlation with increasing gestational age, whereas the absolute area measurements of the germinal matrix increase up to 22 weeks and then decrease. However, there is a gradual decline in the proportionate size of the germinal matrix when compared with the hemisphere from 14 weeks (the earliest case).

CONCLUSION

There is an absolute increase in the size of the fetal germinal matrix up to 22 weeks followed by a reduction to a degree that no matrix is seen after 32 weeks. In proportion to the hemispheric size the germinal matrix is largest at 14 weeks, which was the earliest fetus studied. We will show the appearance of fetal germinal matrices in a range of brain malformations for comparison with the normal data.

KEY WORDS: Germinal matrix

Paper 86 Starting at 3:32 PM, Ending at 3:40 PM

Surface and Nonorthogonal Reconstructions for Assessing Abnormalities of Cortical Formation

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PURPOSE

The detection of developmental abnormalities of the neocortex remains a significant radiologic challenge when focal and anatomically limited. This is relevant because children and young adults with focal seizures are imaged often with a view to possible neurosurgical interventions if an appropriate lesion can be defined confidently. In this paper we evaluate the role of using 3D data sets to produce curvilinear reformats and surface rendered images in order to increase the certainty of diagnosis of neocortical malformations.

MATERIALS & METHODS

Fifty-eight patients were studied all of whom had been reported as having, or suspicious of having, a developmental cortical abnormality on clinical MR imaging at the University of Sheffield between 2000 and 2003. All patients were examined on superconducting 1.5 T systems (Eclipse/Infinion, Philips Medical Systems) and had received gradient-echo T1-weighted volume imaging either with 0.8 mm or 1.0 mm thick partitions. In all cases the 3 space data sets were reconstructed retrospectively using the proprietary workstation to produce non orthogonal reformations of the area of interest. The 3 space data sets were imported in SPM and normalized into standardized space using a template provided by the Montreal Neurological Institute. The images then were transferred to MRICro where a script was used to isolate the brain image from the cranium/superficial structures and perform reconstructions of the cortical surface.

RESULTS

A total of 58 cases were studied falling into the following categories as suggested by Barkovich et al. (1).

Disorder of Abnormal	Radiologic Diagnosis	Numbers
Proliferation	Hemimegalencephaly	5
Migration	Lissencephaly	4
	Heterotopia	15
Cortical organization	Polymicrogyria only	33
	Schizencephaly and PMG	1

High quality 3D data sets were acquired in all patients. All cases of hemimegalencephaly, lissencephaly, and schizencephaly were diagnosed confidently on routine imaging but the reformations gave a better appreciation of the extent of the abnormality. The nonorthogonal reformats made a positive

contribution to the diagnostic process in all cases, whereas some small areas of polymicrogyria and heterotopia did not produce significant distortions of the surface-rendered images.

CONCLUSION

Nonorthogonal reformation and surface-rendered reformats make a positive contribution to the certainty of detection of subtle abnormalities of cortical formation. Even in cases with obvious abnormalities on routine imaging extra information can be obtained with respect to anatomical extent.

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KEY WORDS: Brain malformations

Paper 87 Starting at 3:40 PM, Ending at 3:48 PM

Septo-Optic Dysplasia: Classification and Definitions

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PURPOSE

The classification of midline anomalies is still controversial. Although well recognized, septo-optic dysplasia (SOD) remains an ill-defined malformation and is in need of a definition. Aim of the present study was to establish definitions of this heterogenous group of malformations.

MATERIALS & METHODS

Sixty-nine patients (0-33 years, median 3.9 years) with clinically suspect SOD underwent MR imaging at different institutions. Minimum protocols included axial T2-weighted sequences and at least one 1-3 mm thick sequence that allowed to assess the pituitary and optic structures. Detailed medical records were available in 51 cases. Thirteen morphologic features were assessed (septum pellucidum, corpus callosum, fornix, hippocampi, mamillary bodies, optic structures, pituitary, infundibulum, olfactory nerves, cortex, falx cerebri, anterior commissure, anterior cerebral arteries, pineal gland).

RESULTS

The following cases were excluded from further analysis: Isolated absence of septum pellucidum (8), isolated optic nerve hypoplasia (8), corpus callosum agenesis (5), isolated posterior pituitary ectopia (1), anophthalmia (1), holoprosencephaly (2), muscle-brain-eye disease (1). Within the remaining group six different types can be distinguished according to their morphologic patterns: 1. SOD sensu strictu (10 cases) defined as: Brain with two hemispheres separated by an interhemispheric fissure and connected by a corpus callosum, absent septum pellucidum (ASP) (septal remnants frequently present), fornices present, normal pituitary, normal sized eyes, at least one small optic nerve, no other cerebral malformation, although malrotated hippocampi were present in 50%. Falx cerebri present. 2. SOD plus pituitary involvement (7 cases): as above, but with absent (6/7) or ectopic (1/7) bright spot, small anterior pituitary. Various or combined hormone deficiencies except GnRH. Secondary

hypopituitarism. 3. SOD plus cortical malformation (5 cases): ASP, small optic structures, normal pituitary, cortical malformation. 4. Three patients were characterized by ASP, normal optic structures, ectopic posterior pituitary, small adenohypophysis and frontal cortical dysplasia with maldeveloped callosal genu. 5. Absent rostral falx was the salient feature in this group (8 cases): Small optic structures (8/8), ectopic (2/8) or absent (6/8) bright spot, small anterior pituitary (8/8), thin (5/8) or absent (3/8) infundibulum, ASP (4/8), absent anterior commissure (3/8), cortical malformations, 3/8, malrotated hippocampi (5/8), one case with absent olfactory nerves and additional GnRH deficiency. 6. Schizencephaly: ASP (8/10), pituitary normal (9/10), normal hippocampus, optic structures normal (6/10). A hypoplastic corpus callosum was found in 10/15 patients which were older than 1 year and had hormone deficiencies. Dysplastic corpora callosa were seen in cases of schizencephaly or cortical dysplasia. Hippocampal malrotation usually was associated with small mamillary bodies.

CONCLUSION

A detailed morphologic analysis allows to distinguish well defined groups within this spectrum of malformations. The term SOD should be restricted to group one. Callosal hypoplasia is an additional indicator of hormonal dysfunction. The proposed classification correlates better with outcome and may provide additional clues on the pathogenesis. These findings point to an etiology which primarily affects the embryonic prosencephalon involving the di-telencephalic junction, the exact nature of which remains to be determined. Exact definitions and detailed descriptions are essential to finally cut this Gordian knot.

KEY WORDS: Septo-optic dysplasia, brain malformation, pituitary

Paper 88 Starting at 3:48 PM, Ending at 3:56 PM

Anomalies of the Cerebral Commissures: MR Analysis of the Phenotypic Spectrum

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San Francisco, CA

PURPOSE

Anomalies of the cerebral commissures (ACC, including the corpus callosum, anterior commissure, and hippocampal commissure) are associated with a variable spectrum of neurologic, behavioral, and cognitive deficits. The estimated incidence of ACC is 1 in 4000 live births. To better address the current limited understanding of the etiology and natural history of ACC, we have initiated a project to establish phenotypic groupings of patients with ACC.

MATERIALS & METHODS

The radiology database (1985 to 2003) at our institution was queried with: "callosum" and "hypogenesis" or "dysgenesis" or "agenesis." This yielded 198 patients. We reviewed dictations to identify all likely cases of ACC, which yielded n = 167 cases. An additional 25 cases were drawn from MR examinations of members of the ACC Network, a national support organization for patients with callosal anomalies. Exclusion criteria included inadequate scan quality, second-

Pituitary Volume in Children Diagnosed with Growth Hormone Deficiency

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White Plains, NY

PURPOSE

A retrospective study of MR imaging with contrast of the brain with particular attention to the pituitary gland was undertaken to determine the pituitary size in patients diagnosed with growth hormone deficiency (growth hormone < 10 ng/dL).

MATERIALS & METHODS

Thirty-two patients with growth hormone deficiency were studied. Their mean age was 11.84 ± 3.9 years. Six were female and 26 were male. The mean pituitary volume was 254.94 ± 145.5 cm³. Fifty-four patients undergoing MR imaging for seizures and headaches were used as controls in this study. Their mean age was 6.85 ± 6.1 years. Eighteen were female and 36 were male. The mean pituitary volume was 343.68 ± 186.4 cm³. Patients with major MR imaging abnormalities were eliminated as control subjects. The patients were broken down into prepubertal and pubertal designations. For this study, prepubertal females were defined as anyone age 11 or under, and prepubertal males were defined as anyone age 12 or under.

RESULTS

Figure 1 depicts the pituitary volumes in all control patients vs all growth hormone deficient patients (Bars A, B); prepubertal control patients vs perpubertal growth hormone deficient patients (Bars C, D); and pubertal control patients vs pubertal growth hormone deficient patients (Bars E, F). Table 1 depicts the mean pituitary volume for the three different study pairs, as well as the corresponding p-values for paired t-tests that were performed.

Figure 1. Graphical representation of mean pituitary volume size.

ary commissural anomalies (as from congenital hydrocephalus or large destructive injuries to the brain), holoprosencephaly, and those that are part of known MCA syndromes. The last 3 excluded groups are considered as separate entities and are being evaluated in separate studies. The scans of included patients were evaluated for type and severity of commissural anomalies, presence and type of interhemispheric cyst (if present), presence and type of malformations of cortical development, distortions of the cerebral ventricles, anomalies of white matter (normal or reduced volume, location of reduced volume), presence or absence of Probst bundles, and anomalies of the cerebellum, brainstem, orbits, and olfactory apparatus.

RESULTS

Of 167 patients from our institution, 82 MR studies were available and all 25 ACC network patients had available MR images; thus, studies from 107 patients were reviewed. Forty-four patients had callosal agenesis, 40 had dysgenesis/hypogenesis, 1 had either agenesis or dysgenesis, and 22 were excluded from further review (callosum intact, MCA syndrome, technically limited studies). Fourteen patients had interhemispheric cysts (7 type I and 7 type II) and 3 had an interhemispheric lipoma. An anterior commissure was absent in 36 patients and abnormal in size in 21. No hippocampal commissure was present in 58 patients and abnormal in size in 3. Cortical malformations were present in 52 patients, with heterotopias and abnormal sulcation patterns most common. Cerebral ventricles were dilated or dysplastic in 74 patients, ranging from mild colpocephaly to severe hydrocephalus. Reduced white matter volume was present in 80 patients, with abnormal myelination in 24. Probst bundles were apparent in 24 patients. Anomalies of the cerebellum, brainstem, orbits, and olfactory apparatus also were evident in several patients.

CONCLUSION

Callosal anomalies were by far the most common commissural anomalies. Isolated commissural anomalies are rare among the population of patients examined. Most cases of commissural agenesis or dysgenesis are associated with complex telencephalic, diencephalic, or rhombencephalic malformations. White matter abnormalities are the most frequent MR finding, seen in greater than 80%, while malformations of cortical development are seen in more than half of patients, suggesting that most commissural anomalies are only one part of an overall cortical and white matter dysgenesis.

KEY WORDS: Corpus callosum, agenesis, dysgenesis

Table 1. Comparison of pituitary volumes in controls vs growth hormone deficient patients.

	All Patients		Pre-Pubertal Patients		Pubertal Patients	
	control	GH deficient	control	GH deficient	control	GH deficient
# patients	54	32	38	20	16	12
volume (cm ³)						
mean pituitary	254.94	343.68	271.68	217.93	514.66	316.63
p-value for pair	0.016		0.064		0.015	

Pituitary volumes for each of the three pairs demonstrate that growth hormone deficient patients have smaller pituitary glands than their control counterparts. The growth hormone deficient patients as a whole and the pubertal growth hormone deficient patients as a group show a significant difference in pituitary size compared to their corresponding controls. The difference in pituitary size between the prepubertal deficient patients and their controls was almost significantly different, and a greater number of patients probably would make this difference significant. The data presented here clearly demonstrate that patients with growth hormone deficiency have on average diminished pituitary volume, particularly in the pubertal age group. That, coupled with significant CNS lesions found on MR imaging clearly obligates one to perform MR imaging in all children who are growth hormone deficient.

CONCLUSION

Children with growth hormone deficiency have significantly smaller pituitary volume vs controls and should all undergo CNS MR imaging with contrast with particular attention to the pituitary gland.

KEY WORDS: Pituitary, growth hormone, endocrinology

Paper 90 Starting at 4:04 PM, Ending at 4:12 PM

Brain MR Examinations for Developmental Delay in Children Less than Two Years of Age: The Value of Gadolinium Administration and a Review of Radiologic Findings

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PURPOSE

To review the radiologic findings and associated clinical symptoms in the MR imaging work-up of developmental delay in children less than 2 years of age and evaluate the added utility of gadolinium administration.

MATERIALS & METHODS

During a 7.5-year period (1995-2002), 189 gadolinium-enhanced brain MR examinations were performed on children under 2 years of age for the evaluation of clinical developmental delay. We retrospectively reviewed the medical records, stated indications and MR findings on all 189 cases.

RESULTS

Developmental delay was the primary clinical concern that prompted MR examination in 117 studies (group A) and was secondary to more significant clinical symptoms in 72 studies (group B). Out of these 189 examinations, abnormal contrast enhancement was present in 15 cases (8%). In 4 of the 15, (i.e., 2% of the total number of examinations involving developmental delay) the radiologic finding would have

been missed by noncontrast MR imaging alone. The only case with developmental delay as a primary clinical concern (group A) in which noncontrast MR imaging would have missed a finding represented an incidental venous angioma. The three remaining cases involved developmental delay only as a secondary clinical concern (group B). One case was meningitis that already was suspected clinically and easily confirmed by lumbar puncture, and in the other 2 cases the enhancement proved to be artifact. Group A had 4 cases with abnormal contrast enhancement (3% of group A), which represented incidental findings not related to the primary clinical question (1 intracranial venous angioma, 1 scalp hemangioma, 1 mastoiditis, and 1 Chiari malformation with a distorted choroid plexus). Group B had 11 cases with abnormal enhancement (15% of group B) in which gadolinium increased the confidence and/or clarified the diagnosis in 7 cases (3 neoplasms, 3 tuberous scleroses, and 1 neurofibromatosis 1) and highlighted artifact or incidental findings in the remaining 4. The radiologic findings of the 189 examinations were distributed as follows: normal- 36%, congenital abnormality- 25%, white matter/demyelinating abnormality- 14%, hydrocephalus- 9%, stroke/ischemia- 6%, neoplasm- 5%, other- 5%. The differences between groups A and B were small except for the percentage of normal findings- 43% vs 24%, respectively. The most common symptom to accompany developmental delay was seizures (28% of cases). Other prominent symptoms were neurologic deficits, cranial nerve abnormalities, and failure to thrive.

CONCLUSION

Administration of gadolinium in the brain MR imaging work-up of developmental delay as the primary clinical concern for children less than 2 years of age did not provide clinically useful positive information in this series of examinations.

KEY WORDS: Developmental delay, brain imaging, gadolinium

Paper 91 Starting at 4:12 PM, Ending at 4:20 PM

Frequency of Incidental Subdural Hematoma after Delivery

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PURPOSE

Subdural hematoma are a common sequelae of cranial nonaccidental injury (NAI) in children. In such cases it is a common legal defense to claim that the subdural hematoma was the result of trauma at delivery. In this study we have used MR imaging to estimate the frequency of clinically silent subdural hematoma present in the first few days of life. We have correlated those findings with the mode of delivery and the natural history of the subdural hematoma.

MATERIALS & METHODS

This study was undertaken at the Jessop Wing of the Royal Hallamshire Hospital, Sheffield that has 6000 deliveries per year. The study was approved by the South Sheffield Ethics Committee and was performed with the full informed consent of the parent(s). All neonates were completely asymptomatic at the time of the MR examination and have shown no developmental/neurologic problems on follow-up to 24

months. The MR examination was performed on a 0.2 T permanent magnet system (Niche, Innervision Ltd.) after feeding without sedation or anesthesia, within 48 hours of delivery. Imaging consisted of SE T1-weighted images in the three natural orthogonal planes and SE T2-weighted images in the coronal plane. The total occupancy time was in the order of 20-25 minutes. The examinations were reported by an experienced neonatal radiologist (EW) and pediatric neuroradiologist (PDG) without prior knowledge of the mode of delivery. Neonates with subdural hematoma were reimaged every 4 weeks until the hematoma had resolved.

RESULTS

Over the first 18 months of the study 111 neonates were studied and had clinical follow-up to 24 months. Pathology other than subdurals was seen in one case (cortical infarction). Subdural hematomas were seen in 9 cases with the following relationship to mode of delivery.

Mode of delivery	Total number	Subdurals	Risk (%)
Normal vaginal	49	3	6.1
Caesarean	25	0	0
Forceps only	4	0	0
Ventouse only	13	1	7.7
Failed ventouse to other method	20	5	20

All of the subdural hematomas defined in the first week of life had resolved on the first follow-up scan at 4 weeks.

CONCLUSION

Subdural hematoma do occur asymptotically with an estimated frequency of 8.1%. Delivery assisted by forceps and ventouse have a much higher rate of subdurals. These abnormalities remain asymptomatic and have resolved radiologically by 4 weeks of age.

KEY WORDS: Subdural hematoma

Paper 92 Starting at 4:20 PM, Ending at 4:25 PM

Neonatal Alexander Disease: Review and Comparison of CT, MR Imaging, and MR Spectroscopy Findings

Burrowes, D. M.¹ • Nguyen, P. H.² • Joshi, A.³ • Bassuk, A.¹ • Larsen, M.¹

¹Children's Memorial Hospital, Chicago, IL, ²University of Illinois Chicago-Michael Reese Hospitals, Chicago, IL, ³Northwestern Memorial Hospital, Chicago, IL

PURPOSE

Alexander disease is a progressive neurodegenerative disorder characterized by rostral-to-caudal progression of histopathologic and MR findings. The presentation may be in three forms: infantile, juvenile, and adult. A small subset of patients with the onset during the neonatal period are associated with a severe disease course leading to death. Identification of this early onset is especially important as seizures and signs of increased intracranial pressure may mislead the diagnosis, and none of the clinical or neurologic findings are pathognomonic.

MATERIALS & METHODS

We report here on two cases of the neonatal form of Alexander disease which presented at our institution over a 20-year period, and review the radiologic findings, including the advances of MR imaging with MR spectroscopy, and compare with CT findings, then and now.

RESULTS

In both cases the infants presented with similar nonspecific neurologic symptoms including poor feeding, weight loss, altered respirations with episodes of oxygen desaturation, hypotonia, increased head circumference, and seizures. CT findings in both cases showed hydrocephalus, bilateral basal ganglia hypodensities, bifrontal and temporal lobe white matter hypodensities, and periventricular white matter hyperdensities. The more recent case also had characteristic MR findings including bifrontal and temporal white matter signal abnormalities on T1 and T2, with abnormal signal changes also seen in the basal ganglia. We also report a new finding of serial increases in the lactate and choline peaks and decreases in the N-acetylaspartate peak at MR spectroscopy. Rosenthal fibers were identified in both cases, a unique identifier for this disease process. Finally, the histopathologic analysis of the more recent case demonstrated a novel mutation in the glial fibrillary acidic protein (GFAP) gene, which has been associated recently with this disease.

CONCLUSION

Alexander disease is a rare progressive lethal leukodystrophy characterized by progressive failure of central myelination and accumulation of Rosenthal fibers in astrocytes, predominantly in the subpial, perivascular, and subependymal areas. The underlying defect is not known yet. Laboratory investigations are not helpful in establishing the diagnosis, and biochemical markers do not exist. Previously, Alexander disease was diagnosed histopathologically, but there is agreement that the diagnosis can be made with typical clinical signs and neuroradiologic findings. Our review of these two cases supports this conclusion.

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KEY WORDS: Alexander disease, MR imaging, neurodegenerative

Paper 93 Starting at 4:25 PM, Ending at 4:30 PM**Cortical Dysplasia in Nevus Linear Sebaceous Syndrome: A Further Case**

Fernandes, A. L.¹ • Calado, E.²

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PURPOSE

To describe the MR findings, clinical evolution, and the challenges in the diagnosis of the cranial abnormalities in a case of nevus linear sebaceous syndrome (NLSS).

MATERIALS & METHODS

We followed until now a child who presented to the neuro-pediatric outpatient clinic with seizures when he was 8 months old. He is now 17 years old. The CT and MR scans and cerebral biopsy results were checked. The literature was reviewed.

RESULTS

The NLSS is a rare neurocutaneous syndrome characterized by epidermal nevi and cranial abnormalities such as skull asymmetry, hemimegalencephaly, and ventricular system asymmetry. A spectrum of pathologic findings had been described in the brain parenchyma: cortical dysplasia, glioneural hamartomas, neuronal heterotopias, micropolygyria. Very rarely the malformation involves frank tumors such as desmoplastic neuroepithelial tumor, pilocytic astrocytoma, and choroid plexus papiloma, according to the cases reported. Herein we report a case of a child who developed West syndrome and left hemiparesis by the age of 8 months. MR imaging showed an abnormal high signal in the right cortical and subcortical parietal and temporal regions on T2-weighted images. No significant surrounding edema nor mass effect were observed. The lesion didn't enhance after gadolinium. At that time a brain biopsy was inconclusive between two possible diagnosis: ganglioglioma and balloon cell dysplasia. By the age of 10 the appearance of the epidermic nevi lead to the definitive diagnosis of NLSS and both clinical and radiologic evolution suggest associated dysplasia rather than tumor.

CONCLUSION

In this case only through the finding of the cutaneous lesion and the subsequent clinical and radiologic evolution did the final diagnosis lead to NLSS.

KEY WORDS: Phakomatosis, dysplasia, nevus linear sebaceous

Monday Afternoon

3:00 PM - 4:30 PM

Room 602 - 603

(13) ELC Workshop B: PowerPoint for Advanced Users

— *H. Christian Davidson, MD*

— *Richard H. Wiggins, III, MD*

Monday Afternoon

4:40 PM - 5:40 PM

Room 606 - 609

(14) ELC Lecture D: CD & DVD
Expertise: What You Need to Know

— *Barton F. Branstetter, IV, MD*

Monday Afternoon

4:40 PM - 6:10 PM

Room 611 - 612

(15) Treatment of CNS Pediatric Neoplastic Disease: Response & Complications (ASPNR)

(15a) Overview of Pediatric Central Nervous System Neoplasms

Roger Packer, MD

(15b) Neuroradiologists' Approach to Pediatric CNS Neoplasms

Robert A. Zimmerman, MD

(15c) The Central Role of Neuroimaging in Radiation Therapy Planning: Delivery & Follow-up

Thomas E. Merchant, DO, PhD

(15d) Role of Chemotherapy and Molecular Targeted Therapy for Brain Tumors

Roger Packer, MD

(15e) Complications of Radiation and Chemotherapy

Lucy B. Rorke, MD

Moderators: Robert A. Zimmerman, MD
Lucy B. Rorke, MD

tumors. Specifically, the improved survival rate for children with medulloblastoma will be reviewed and factors associated with survival will be discussed. In addition, the role of chemotherapy to potentially decrease radiation-associated treatment sequelae will be covered. In contrast, outcome for children with high-grade gliomas, especially brain stem gliomas, remains dismal and new approaches for management now are under evaluation. Pediatric infantile brain tumors remain a highly problematic subset of pediatric brain tumors. Over the past decade, a new subset of tumors, the atypical teratoid/rhabdoid neoplasm, has been characterized and comprises a significant proportion of embryonal brain tumors in children less than three years of age. Also, the high morbidity associated with pediatric brain tumor "cure" will be discussed.

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Neuroradiologists' Approach to Pediatric CNS Neoplasms

Robert A. Zimmerman, MD

LEARNING OBJECTIVES

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

- 1) Define an approach to the interpretation of pediatric neuroimaging studies in the follow-up of brain tumor therapy that will lead to recognition of both radiation and chemotherapeutic complications

- 2) Identify that therapeutic CNS complications of systemic hematologic malignancy initiate diffusion imaging, MRV and MRA, in addition to routine MR imaging

PRESENTATION SUMMARY

The information and experience derived over the past 20 years of MR imaging have made the neuroradiologist comfortable with the recognition and differential diagnosis of primary pediatric CNS neoplasms. The more recent addition of newer techniques, MRS and diffusion imaging, has further helped in this regard. The frontier in imaging is now in the response to treatment and the differentiation of complications of treatment, radiation and chemotherapeutic damage from recurrent or new primary neoplasms. This session is to focus our attention on the problem, relative to the insight our colleagues in neurooncology, radiation therapy, and neuropathology can provide, in better understanding the pathophysiology that underlies the image.

Overview of Pediatric Central Nervous System Neoplasms

Roger Packer, MD

LEARNING OBJECTIVES

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

- 1) Recognize the incidence of childhood brain tumors
- 2) Discuss the likelihood of long-term survival and quality of survival of children with brain tumors
- 3) Describe new approaches in the management of childhood brain tumors

PRESENTATION SUMMARY

The incidence and outcome of brain tumors occurring in childhood will be addressed. Emphasis will be placed on the event-free and overall survival rates of pediatric brain

The Central Role of Neuroimaging in Radiation Therapy Planning: Delivery & Follow-up

Thomas E. Merchant, DO, PhD

Dr. Merchant is Chief of Radiation Oncology at St. Jude Children's Research Hospital in Memphis, Tennessee. His practice is devoted exclusively to children and predominantly brain tumors at the largest pediatric radiotherapy facility in the Western Hemisphere. Dr. Merchant has practiced at St. Jude since 1996. Prior to that time, he worked as a resident and later was an attending physician in the Department of Radiation Oncology at Memorial Sloan-Kettering Cancer Center in New York. At Memorial Sloan-Kettering Cancer Center, he was also an American Cancer Society Clinical Oncology Fellow. Dr. Merchant was trained as a nuclear engineer at the University of Michigan. He worked for the French Atomic Energy Commission prior to attending medical school at the Chicago College of Osteopathic Medicine. After medical school he was selected as a Fulbright Scholar to the Netherlands at the University of Utrecht. There he received his Ph.D., cum laude, in experimental pathology. The focus of Dr. Merchant's current work is the application of advanced radiotherapy treatment technology in children with brain tumors and the study of radiation-related CNS effects. He has a laboratory devoted to investigating the effects of radiation on cerebral vascular permeability and inflammation. His current trial of conformal radiation therapy for localized primary CNS tumors in pediatric patients has provided the necessary preliminary data for the next generation of COG studies and is likely to enhance our understanding of the clinical effects of radiotherapy on the CNS in children. Dr. Merchant has authored and co-authored more than 100 papers in the primary scientific literature. He also has contributed to numerous chapters and meeting abstracts. He is actively involved in the CNS committee of the Children's Oncology Group. He is principle investigator for the COG ependymoma study and serves as the radiotherapy coordinator for numerous other studies in COG and the pediatric brain tumor consortium. His research has been funded by the American Cancer Society, the Genentech Foundation for Growth and Development, and the American Lebanese Syrian Associated Charities.

LEARNING OBJECTIVES

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

- 1) Recognize the current role of neuroimaging in radiation therapy
- 2) Identify the relationship between radiation dosimetry and side effects

PRESENTATION SUMMARY

Three-dimensional neuroimaging is the basis for modern radiation therapy for childhood brain tumors and is required for dose calculation as well as normal and target volume definition and follow-up. Although MR-based dose calculations are envisioned for the future, tissue density derived from CT data is still used to discriminate tissue types and perform dose calculations. The trend to target and treat smaller volumes mandates the incorporation of MR imaging in the treatment planning process to define the target volume (tumor or tumor bed), the region at risk for recurrence and normal tissues to be spared in the development of the optimal treatment plan. Tissue-specific imaging sequences and the use of multimodality imaging further refines target and normal tis-

sue definitions and remains a strong area of research. The timing of imaging is pertinent for patients who receive radiation therapy: changes in ventricle volume and the shift of intracranial contents must be stable at the time of planning, imaging during radiation therapy has been found to be necessary for patients with tumor types prone to cyst enlargement and changes observed after radiation therapy may confound interpretation and response evaluation. Knowledge of the distribution of dose within specific volume of the brain can be used to predict for radiation-related treatment effects. Efforts to optimize treatment in the future will be based on refining treatment dosimetry to spare functional elements of the brain.

Role of Chemotherapy and Molecular Targeted Therapy for Brain Tumors

Roger Packer, MD

LEARNING OBJECTIVES

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

- 1) Define new approaches utilizing molecular targeted therapy for childhood brain tumors
- 2) Indicate new neuroradiographic techniques required in assessing the efficacy and toxicity of molecular targeted therapy and antiangiogenesis drugs
- 3) Recognize new delivery approaches utilized in management of childhood brain tumors, including convection delivery

PRESENTATION SUMMARY:

The changing treatment of childhood brain tumors will be discussed. Over the past decade, there has been an explosion in the understanding of childhood brain tumors, especially the molecular genetic changes associated with the development of brain tumors. These molecular genetic alterations are being used already to stratify patients into risk groups. Molecular targeted therapy is being incorporated into pediatric brain tumor trials utilizing drugs that interrupt with cell signaling pathways and block cell surface growth factor receptors. In addition, antiangiogenesis drugs are in clinical trials. These therapies, which often are used as adjuncts to standard chemotherapy and radiation therapy, require careful neuroradiographic assessment for both efficacy and toxicity. Early experience with antigrowth factor receptor agents utilized with radiotherapy suggests an increased incidence of intratumoral hemorrhage. The neuroradiographic needs for these types of studies will be addressed. In addition, new drug delivery systems are being investigated in pediatrics. Neuroradiographic assessment will be critical in the assessment of the utility of such approaches.

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Complications of Radiation and Chemotherapy

Lucy B. Rorke, MD

LEARNING OBJECTIVES

Upon completion of this session, participants will be able to:
1) Identify treating children with CNS tumors that use of radiation and chemotherapy is simultaneously both beneficial and harmful

2) Recognize treating children with CNS tumors that use of radiation and chemotherapy can damage the child in a number of specific ways quite different from the direct effects of the tumor itself

PRESENTATION SUMMARY

There are four major morphologic complications that may occur following radiation/chemotherapy for CNS tumors in childhood. These include a variety of vascular lesions, tissue necrosis, changes in histologic features of the tumor and development of a second tumor years after treatment. Damage to the vessels may take the form of necrosis, sclerosis with or without calcification, aneurysm formation or abnormal proliferation. Necrosis is typically bland and at times undergoes calcification. Changes in the histology are sometimes dramatic and occasionally involve complete transformation of original diagnostic features to a partial or complete change in phenotype. This generally involves an overgrowth of one cell type that was a component of the original tumor. For example, one child had an ependymoma that underwent transformation into a primitive neuroectodermal tumor with ependymal differentiation. Another with a complex AT/RT at biopsy, was composed solely of bizarre rhabdoid cells postmortem. Probably most important is the genesis of a second tumor years after apparent cure of the primary neoplasm. These vary in type, although anaplastic astrocytoma and glioblastoma multiforme are the most common.

Monday Afternoon

4:40 PM - 6:10 PM

Ballroom 6 B/C

(17) Advanced Imaging Seminar - Diffusion

(17a) Overview of Physiologically Specific Neuroimaging

Michael W. Weiner, MD

(17b) Basics and Clinical Applications of Diffusion-Weighted Imaging

P. Ellen Grant, MD

(17c) Diffusion Tensor Imaging Techniques and Terminology

Thomas E. Conturo, MD, PhD

(17d) Diffusion Tensor Imaging Fiber Tracking

Pratik Mukherjee, MD, PhD

Moderators: Timothy P.L. Roberts, PhD
Howard A. Rowley, MD

Monday Afternoon

4:40 PM - 6:10 PM

Ballroom 6 A

(16) Stump the Stars (ASHNR)

Patricia A. Hudgins, MD

Suresh K. Mukherji, MD

H. Ric Harnsberger, MD

Moderator: David M. Yousem, MD

Overview of Physiologically Specific Neuroimaging

Michael W. Weiner, MD

Michael W. Weiner, M.D. is the Director of the Magnetic Resonance Unit at the Veteran's Administration Medical Center in San Francisco, and Professor of Radiology, Medicine, Psychiatry and Neurology at the University of California San Francisco. He has been performing research since 1968 and was one of the first scientists to obtain MR spectroscopy (MRS) spectra from an intact animal, and has published over 310 peer-reviewed journal publications, of which 250 have been clinical MR imaging/MRS studies. Since his early MRS studies showing reduced N-acetyl aspartate in epilepsy and AD, he has focused on the use of MR imaging/MRSI to characterize effects of aging and dementia and other neurodegenerative diseases. Although his early work on AD focused on MRS, he and his coworkers subsequently used MR imaging tissue segmentation and hippocampal voluming alone and together with MRS to investigate changes associated with normal aging, white matter lesions, vascular and mixed dementia, and frontotemporal dementia in addition to AD. More recently, he has used structural MR imaging to investigate rates of hippocampal, entorhinal cortex, and whole brain tissue change in normal aging, effects of cerebrovascular disease, and AD.

LEARNING OBJECTIVES

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

- 1) Identify the principles of arterial spin labeled MR imaging
- 2) Describe the information derived from MRSI
- 3) Distinguish between the advantages and disadvantages of MR imaging at fields above 1.5 T
- 4) Define the changes which occur in neurodegenerative diseases
- 5) Define the changes which occur in epilepsy

PRESENTATION SUMMARY

The role of structural MR imaging, perfusion MR imaging, and MR spectroscopy to measure function, physiology, and metabolism will be addressed. Emphasis will be on the use of these techniques to determine effects of various neurodegenerative diseases. Specifically, various brain diseases can be identified largely by the regionality of changes, rather than the specific nature of the change. Examples from the presenters research on Alzheimer's disease and other dementias, cerebrovascular disease, and epilepsy will be presented. Finally, the advantages of MR imaging at fields greater than 1.5 T will be discussed.

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Basics and Clinical Applications of Diffusion-Weighted Imaging

P. Ellen Grant, MD

LEARNING OBJECTIVES

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

- 1) Identify the types of disorders associated with low ADC
- 2) Examine the clinical situations where regions with decreased ADC return to normal with minimal to no tissue destruction
- 3) Illustrate and assess the limitations of DWI and ADC in detecting cell death

PRESENTATION SUMMARY

This talk will focus on the practical clinical applications of diffusion-weighted imaging (DWI) and the interpretation of DWI findings in a wide spectrum of disorders seen in clinical

practice when imaging both children and adults. The basic concepts of diffusion-weighted imaging will be reviewed briefly with comments on b value optimization and eddy current corrections. Although DWI first gained popularity in the diagnosis of hyperacute and acute stroke, there are many clinical situations in which bright DWI and low apparent diffusion coefficient (ADC) lesions are seen. The possible etiologies and differential diagnosis of bright DWI/low ADC lesions will be reviewed and a number of clinical examples in each category provided. In general, it appears that decreased ADC can be associated with 1) Failure or dysfunction of cellular energy metabolism, 2) Some types of myelin vacuolization/active demyelination/axonal swelling, 3) High cellular density or 4) Turbid or viscous material. Unusual cases with apparent ADC reversal and with delayed onset of ADC decrease will be discussed.

Diffusion Tensor Imaging Techniques and Terminology

Thomas E. Conturo, MD, PhD

Dr. Conturo received his bachelor's degree in chemistry and biochemistry at the University of Pennsylvania in 1981. He then received his M.D. and Ph.D. (in biophysics) from Vanderbilt University in 1989, doing his Ph.D. work in MRI physics. He did a residency in Diagnostic Radiology at Johns Hopkins from 1989-1993, including an NIH NCI post-doctoral fellowship. He then became Assistant Professor of Radiology at Mallinckrodt Institute of Radiology at Washington University in St. Louis in 1993, and then Associate Professor in 1999. He previously has held an ASNR Basic Science Research Fellowship, and is board-certified in Diagnostic Radiology.

LEARNING OBJECTIVES

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

- 1) Review diffusion tensor imaging (DTI) terminology
- 2) Describe the various parameters that can be measured by DTI, and their image appearance
- 3) Determine various DTI anisotropy parameters and their use
- 4) Define new variations of diffusion measurements that have neuroradiologic potential

Diffusion Tensor Imaging Fiber Tracking

Pratik Mukherjee, MD, PhD

LEARNING OBJECTIVES

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

- 1) Identify the physical basis for diffusion tensor imaging (DTI) fiber tracking and review the practical considerations involved in acquiring DTI images suitable for fiber tracking
- 2) Define the potential clinical applications of diffusion tensor imaging (DTI) fiber tracking as well as its current limitations
- 3) Determine the strengths and weaknesses of the different techniques for performing DTI fiber tracking

PRESENTATION SUMMARY

Diffusion tensor imaging (DTI) is an area of burgeoning research in both technical refinements and clinical applications. Diffusion MR images reflect information on a microscopic spatial scale, allowing researchers and clinicians an unprecedented ability to noninvasively probe tissue microarchitecture. White matter tracts in the human brain that have fibers coherently organized into parallel bundles exhibit diffusion anisotropy: water diffusion along the direction of the fiber tracts is greater than that perpendicular to the fiber tracts. With DTI, the fiber orientation within these white matter tracts can be determined; hence, fiber tractography based on DTI can reveal the three-dimensional white matter connectivity of the human brain. In this presentation, current techniques for performing DTI fiber tracking are examined, broadly categorized into "streamline" and "probabilistic" methods. The present limitations of each of these methods also are considered, as well as the issue of validating the results of fiber tracking. Examples are provided of the normal anatomy of the human brain delineated with DTI tractography, such as the separation of associational, projectional, and commissural white matter tracts. Methods for quantifying the results of DTI fiber tracking are introduced, with applications that include the quantitative assessment of white matter development in newborns and children. Finally, areas of ongoing clinical research are reviewed, including the presurgical mapping of white matter pathways in combination with functional localization techniques such as functional MR imaging (fMRI), magnetoencephalography (MEG), and intraoperative cortical stimulation.

Monday Afternoon**5:40 PM - 6:10 PM****Room 606 - 609**

(18) ELC Roundtable: Q & A with
Today's Speakers

Barton F. Branstetter, IV, MD

H. Christian Davidson, MD

John L. Go, MD

Gregory L. Katzman, MD

David S. Martin, MD

Gerard J. Muro, MD

Hervey D. Segall, MD

Richard H. Wiggins, III, MD

Notes:

NOTE ABOUT SCANNED IMAGES: Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2004.

Tuesday Morning

8:00 AM - 9:30 AM

Room 606 - 609

(19) Tumors (ASPNR)

(19a) Pediatric Brain Tumor Imaging Protocols and Diffusion Imaging Applications

— Tina Y. Poussaint, MD

(19b) Usefulness of MR Spectroscopy in Pediatric Brain Tumors

— Kim M. Cecil, PhD

(19c) MR Perfusion and Pediatric Brain Tumors

— Soonmee Cha, MD

Moderators: Tina Y. Poussaint, MD
Gilbert Vezina, MD

vivo characterization of rate and direction of white matter diffusion. Such information is useful for presurgical planning or coregistration of tractography data with radiosurgical planning and functional MR data (6). Fractional anisotropy using DTI may prove helpful for assessment of treatment-induced white matter injury in children (7).

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Pediatric Brain Tumor Imaging Protocols and Diffusion Imaging Applications

Tina Y. Poussaint, MD

LEARNING OBJECTIVES

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

- 1) Develop standardized imaging protocols for pediatric brain tumors
- 2) Apply diffusion imaging of children with brain tumors

PRESENTATION SUMMARY

Neuroimaging protocols for pediatric brain tumors will be reviewed and emphasized. The role and requirements of standardized brain imaging protocols through multicenter consortia will be addressed. The added value of MR diffusion imaging in pediatric brain tumors will be covered. Diffusion imaging using echo-planar or line scan techniques has been helpful in the assessment of tumor cellularity, classification of tumor grade, and assessing response to therapy (1-4). Diffusion imaging of brain tumors using multi-b factors especially in the high range of b factors may play a future role in distinguishing edema from tumor (5). Diffusion tensor imaging provides visualization of fiber bundle direction and integrity with in

Usefulness of MR Spectroscopy in Pediatric Brain Tumors

Kim M. Cecil, PhD

LEARNING OBJECTIVES

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

- 1) Recognize key metabolic features useful for discriminating pediatric neoplasms
- 2) Describe how to protocol the spectroscopic examination
- 3) Integrate spectroscopic interpretation with conventional and advanced imaging findings

PRESENTATION SUMMARY

This session will familiarize and update the neuroradiologist with the usefulness of MR spectroscopy (MRS) in assessing pediatric brain tumors. MR spectroscopy can aid with the initial discrimination of benign vs malignant pediatric neoplasms. In this session, we will identify the metabolite changes useful for discriminating tumor from other pathologies (i.e., dysplasia) as well as tumor grade classification (i.e., low grade glioma). As some brain regions are surgically inaccessible, such as the brainstem, a noninvasive metabolic

"biopsy" provided by MRS is especially useful in the pediatric population. Planning surgical and/or radiation therapies requires knowledge of the tumor grade and the extent of the malignancy. Sampling with multiple echo times affords useful information for grading the tumor. MR spectroscopic imaging provides a sensitive method for detecting the extent of tumor involvement. MR spectroscopy when combined with advanced imaging techniques such as diffusion and perfusion, enables higher diagnostic specificity. The integration of spectroscopy and advanced imaging is especially important in the follow-up of treated brain tumors. While no one technique is 100% sensitive and specific, the combination of spectroscopic and imaging techniques are continually improving our ability to discriminate tumor from treatment effects.

MR Perfusion and Pediatric Brain Tumors

Soonmee Cha, MD

LEARNING OBJECTIVES

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

- 1) Recognize basic technique and clinical application of dynamic susceptibility contrast-enhanced perfusion MR imaging
- 2) Assess potential added value of perfusion MR imaging in evaluating pediatric patients presenting with intracranial mass lesion
- 3) Describe pathophysiologic and biologic correlate of perfusion MR imaging.
- 4) Assess pitfalls and limitations of perfusion MR imaging

PRESENTATION SUMMARY

The basic principle and clinical application of dynamic susceptibility contrast-enhanced perfusion MR imaging in pediatric brain tumors will be presented. Emphasis will be on the utility of perfusion MR imaging in evaluating pediatric patients with intracranial mass lesion and in differentiating brain neoplasm from tumor-mimicking lesion such as abscess, developmental dysplasia, and demyelinating disease. Perfusion MR imaging protocol, image processing, and quantitative analysis method will be reviewed briefly. The added value of perfusion MR imaging in assessing tumor type and grade, angiogenesis, and permeability will be discussed. Perfusion MR imaging features of low-grade tumors with unique vascular morphology such as juvenile pilocytic astrocytoma, ganglioglioma, and dysembryoplastic neuroepithelial tumor will be introduced. Potential pitfalls and limitations of perfusion MR imaging, especially in imaging posterior fossa tumors in pediatric patients, will be addressed.

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Tuesday Morning

8:00 AM - 9:30 AM

Ballroom 6 B/C

(20) MDCT in the Evaluation of Sinonasal Disease (ASHNR)

(20a) Sinus Inflammatory Disease

— Yoshimi Anzai, MD

(20b) Sinus Neoplasms

— C. Douglas Phillips, MD

(20c) Developmental/Congenital Lesions

— Anton N. Hasso, MD, FACC

Moderators: Patricia A. Hudgins, MD
H. Ric Harnsberger, MD

Sinus Inflammatory Disease

Yoshimi Anzai, MD

LEARNING OBJECTIVES

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

- 1) Describe normal anatomy of paranasal sinuses and anatomical variations
- 2) Review sinus drainage patterns and imaging features of sinus inflammatory disease
- 3) Define key imaging features to assist endoscopic sinus surgery
- 4) Describe various types of endoscopic sinus surgery and post-op CT findings

PRESENTATION SUMMARY

CT has long been an imaging modality of choice for sinus inflammatory disease. There are 3 types of protocols in our institution depending on clinical indications. Screening sinus CT is a quick and low-cost evaluation of sinuses and widely performed to diagnose or exclude acute sinusitis. Fine cut coronal CT is preferred for preoperative evaluation of chronic sinusitis by primarily ENT surgeons. High-resolution volumetric acquisition with multiplanar reconstruction is employed for intraoperative assistant for endoscopic sinus surgery. The recent advent of multidetector CT technology provides greater scanning speed and routine multiplanar display capability. Paranasal sinuses have fairly complex anatomy with wide range of variation, as the sinus is considered "finger printing" of head and neck structures. Detailed knowledge of 3-dimensional anatomies of paranasal sinuses is essential to assist functional endoscopic sinus surgery as

well as evaluate postop patients with recurrent or persistent symptoms. We will discuss the following materials in this lecture. 1. Normal sinus anatomy and anatomical variations. 2. Sinus drainage patterns. 3. Imaging features of sinus inflammatory disease: a. Acute bacterial sinusitis, b. Chronic sinusitis, c. Allergic sinusitis, d. Fungal sinusitis, e. Granulomatous disease. 4. Imaging findings to assist FESS (functional endoscopic sinus surgery): a. Types of FESS. b. What surgeons look for. c. Impact of CT on surgeon's treatment decisions for chronic sinusitis. 5. Postop endoscopic sinus surgery.

Sinus Neoplasms

C. Douglas Phillips, MD

LEARNING OBJECTIVES

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

- 1) Identify the more common sinus neoplasms seen in an active clinical practice
- 2) Assess reasonable imaging protocol to evaluate the patient with known or suspected sinus neoplasia
- 3) Discuss TNM tumor staging for sinus neoplasia, in light of the imaging evaluation in patients with sinus neoplasia

PRESENTATION SUMMARY

Sinus neoplasia is a constant concern of the imaging physician, as the clinical signs and symptoms of benign and malignant sinus disease are the same, and both may present a similar appearance on an imaging study. A careful clinical exam and judicious biopsies are often the best diagnostic method. The imaging evaluation of the patient with sinus neoplasia should be focused on depiction of the extent of disease; involvement of the sinus cavities in distinction from obstructive sinus disease, invasion of contiguous structures, and perineural or lymphatic tumor spread. Squamous cell carcinoma is the model for aggressive neoplasia of the sinuses, and causes irregular bone destruction and may invade adjacent structures. Minor salivary gland neoplasia is a more uncommon form of sinus malignancy, as are melanoma, lymphoma, and spindle cell tumors. Within the superior nasal cavity, the wider variety of cell types lead to other unusual sinus neoplasms, such as esthesioneuroblastoma and sinonasal undifferentiated carcinoma. The imaging evaluation of these lesions typically will include both MR imaging and CT. Nodal metastases may occur later or with advanced disease. Involvement of the orbit, cavernous sinuses, and intracranial compartment indicate advanced disease and have poor prognoses. Benign neoplasms of the sinonasal cavities include a variety of polyps and papillomas, bony and fibrous lesions, and unusual tumors such as juvenile angiofibromas. These lesions also are accompanied by bony change, and the presence of or absence of bone involvement cannot accurately categorize benign vs malignant disease. A representative sample of both benign and malignant sinus lesions will be depicted and discussed and a proposed imaging protocol for the complete evaluation of these patients will be discussed. An approach to the differential diagnoses of these lesions also will be presented. The TNM tumor staging for sinus malignancy also will be discussed.

Developmental/Congenital Lesions

Anton N. Hasso, MD, FACC

LEARNING OBJECTIVES

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

- 1) Recognize that imaging of midface congenital anomalies will help in classifying and differentiating lesions
- 2) Indicate frontonasal dysplasias are often associated with intracranial anomalies. Such lesions should be identified on imaging studies
- 3) Differentiate between developmental fibro-osseous lesions of the midface and similar sinonasal neoplasms

PRESENTATION SUMMARY

While various CT techniques (MD CT, 3D CT) are desirable in the evaluation of congenital and developmental anomalies in infants and young children, there is an essential role for MR imaging whenever there are related intracranial anomalies. This presentation will focus on describing and classifying the known cranio-facial anomalies that are commonly manifest in the sinonasal cavities and mid-face. Cephaloceles (encephaloceles, meningoencephaloceles) may be located in the mid-face and anterior cranial fossa. These are classified as sincipital, basal, or associated with cranioschisis. Cases with cranioschisis have associated anomalies of the mid-face that together form the median cleft face syndrome, typically with clefting of the nose, premaxilla, and hard palate. Midline nasal masses include nasal dermoid sinus or cysts, epidermoid tumors, or nasal gliomas. Three varieties of choanal atresia may be seen—pure bony, mixed bony-membranous, and pure membranous atresia. The congenital heart defects, choanal atresia, retarded growth and development, hypogenitalism, and aural anomalies (CHARGE) association should be suspected in infants presenting at birth with choanal atresia. CT is the most useful tool for the diagnosis of choanal atresia. Hypoplasia of the maxillary sinuses may be seen in association with other facial anomalies, including the Treacher-Collins syndrome (mandibulofacial dysostosis), Goldenhar syndrome (hemifacial microsomia) and the Pierre Robin syndrome.

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Tuesday Morning**8:00 AM - 9:30 AM****Room 602 - 603****(21) ELC Workshop A: PowerPoint for the Novice**— *David S. Martin, MD*— *John L. Go, MD***Tuesday Morning****8:00 AM - 12:00 PM****Room 302****(22) ASNR Grant Writing Seminar: Practical Tips on Getting Your Grant Funded - Part II**— *Janet S. Rasey, PhD**See Session 5 on Monday, June 7 for Learning Objectives and Presentation Summary.***Tuesday Morning****10:15 AM - 11:45 AM****Ballroom 6 B/C****(23a) Adult Brain: Epilepsy (Scientific Papers 94 - 105)***See also Parallel Sessions**(23b) Head & Neck: General**(23c) Pediatrics: General, Functional, and Vascular Imaging**(23d) Pediatrics: General and Leukoencephalopathy*Moderators: *Jacqueline A. Bello, MD*
*William P. Dillon, MD***Paper 94 Starting at 10:15 AM, Ending at 10:23 AM****Diffusion Tensor Imaging and High Resolution Brain MR Imaging: A Comparison Study Lateralizing the Seizure Focus in Temporal Lobe Epilepsy**Faro, S. H.¹ • Mohamed, F.¹ • Khaled, K. J.¹ • Williams, M.¹ • Yazeji, M. S.² • Assaf, B.²¹Drexel University, Philadelphia, PA, ²University of Illinois, Peoria, IL**PURPOSE**

Diffusion tensor imaging (DTI) is a noninvasive technique that can assess the microstructure of cerebral tissue. Increased diffusivity in the hippocampus (HC) during DTI measurements has been demonstrated to correlate with the seizure focus in TLE. High resolution brain MR imaging is an established technique for detecting hippocampal atrophy or abnormality and lateralizing the seizure focus. However, the relative contribution of both techniques in lateralizing the epileptogenic temporal lobe is still unknown. The purpose of this study was to compare the relative value of DTI of the hippocampal formation and high resolution brain MR imaging in lateralizing the seizure focus in temporal lobe epilepsy (TLE).

MATERIALS & METHODS

We performed DTI and high resolution brain MR imaging on a total of 23 TLE patients. We acquired DTI by collecting diffusion-weighted images along six different directions with a b value of 1000 sec/mm² as well as an image acquired without diffusion weighting (b = 0 sec/mm²). Seventeen 3mm slice thickness, coronal slices covering the temporal lobes were imaged using a 1.5 T scanner. The imaging parameters included: TR = 6000 ms, TE = 100 ms, FOV = 240, 98 x 128, and 4 acquisitions. We obtained the diffusivity (trace D) and fractional anisotropy (FA) values from symmetrical voxels sampling the head of the hippocampus bilaterally. High resolution structural T2-weighted inversion recovery images were acquired also at the same locations. Imaging parameters include: TR = 5500 ms, TE = 90 ms, FOV = 240 mm, 260 x 512, T1 = 150 ms, and 1 acquisition. We determined abnormal DTI measurements by comparing HC diffusivity and FA values to those of normal subjects and determined abnormal high resolution brain MR imaging in the entire group of patients. Subsequently, we correlated DTI and high resolution MR imaging with the epileptogenic temporal lobe as determined by the clinical localization.

RESULTS

Diffusion tensor imaging was abnormal in 16 of 23 patients (sensitivity 70%) and accurately lateralized the epileptogenic region in all 16 cases while high resolution brain MR imaging was abnormal in 17 of 23 patients (sensitivity 78%) and lateralized the epileptogenic temporal lobe in all 17 patients. Three patients with negative high resolution brain MR imaging demonstrated abnormal DTI measurements while the three other patients demonstrated negative high resolution MR imaging and negative DTI studies.

CONCLUSION

There is a high concordance between high resolution brain MR imaging and DTI in detecting the epileptogenic temporal lobe in TLE. Diffusion tensor imaging is a useful technique that may play an additive value to high resolution MR

imaging in presurgical evaluation of TLE. In addition, both techniques may play a complementary role in detecting the seizure focus in TLE.

KEY WORDS: Diffusion tensor imaging, temporal lobe epilepsy

Paper 95 Starting at 10:23 AM, Ending at 10:31 AM

Apparent Diffusion Coefficient of Hippocampus in Mesial Temporal Lobe Epilepsy

Kanodia, A. K. • Gaikwad, S. B. • Mishra, N. K. • Garg, A. • Tripathi, M. • Padma, M. V. • Chandra, P. S. • Sharma, M. C. • Gupta, V.

All India Institute of Medical Sciences
New Delhi, INDIA

PURPOSE

To evaluate apparent diffusion coefficient (ADC) values in hippocampus in MR imaging positive and negative patients of mesial temporal lobe epilepsy.

MATERIALS & METHODS

Apparent diffusion coefficient values were calculated in 8 controls (22-50 years, mean 29.5 years, 3 males and 5 females) and 30 patients of mesial temporal epilepsy. Apparent diffusion coefficient values were calculated using 3 mm sections along the long axis of hippocampus using 3 regions of interest from anterior, middle, and posterior parts. Patients were divided into 3 groups: Unilateral MR imaging positive (Group 1) (15 patients including 12 males and 3 females, 12-43 years, mean 20.6 years), bilateral MR imaging positive (Group 2) (4 patients, all males, 14-23 years, mean 17 years) and MR imaging negative (Group 3) (11 patients, 9 males and 2 females, 8-37 years, mean 24.5 years). Normal range of ADC values was taken as mean $\pm$ 2SD of the control group. Group and individual comparisons were performed.

RESULTS

Significantly high ADC values were obtained on ipsilateral side in Group 1 and 2 and on contralateral side in Group 2. Apparent diffusion coefficient values in MR imaging negative group were not increased significantly. In Group 1, ADC values were increased on ipsilateral side only in 9 patients and on both sides in 5 patients (ipsilateral > contralateral). In 1 patient, normal values were seen on both sides (contralateral > ipsilateral). In Group 2, increased ADC values were seen on both sides in all patients (ipsilateral > contralateral). In Group 3, ADC values were increased on ipsilateral, contralateral, and both sides in 3, 2, and 2 patients, respectively. In patients with increased ADC values on both sides, contralateral and ipsilateral values were higher than other side in 1 patient each. Normal ADC values were seen in 4 patients in Group 3.

CONCLUSION

Apparent diffusion coefficient values are helpful in lateralizing the side of seizure focus in unilateral and bilateral MR imaging positive patients of mesial temporal lobe epilepsy. In MR imaging negative patients, it may produce contradictory results and has low sensitivity.

KEY WORDS: Diffusion, epilepsy, hippocampus

Paper 96 Starting at 10:31 AM, Ending at 10:39 AM

Qualitative Evaluation of Glx (Glutamate + Glutamine) Ratios with Other Metabolites in Evaluation of Mesial Temporal Sclerosis

Kanodia, A. K. • Gaikwad, S. B. • Mishra, N. K. • Garg, A. • Padma, M. V. • Tripathi, M. • Gupta, V. • Chandra, P. S. • Sharma, M. C.

All India Institute of Medical Sciences
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PURPOSE

Ratios of glx (glutamine + glutamate) with other metabolites to lateralize seizure focus in mesial temporal lobe epilepsy.

MATERIALS & METHODS

We performed qualitative MRS using single-voxel PRESS (point resolved spectroscopy) with short TE (TE = 30 ms) in 33 patients of mesial temporal lobe epilepsy and 10 controls using 2 x 2 x 2 cm voxels. Patients were divided in 3 groups: Group 1 (Unilateral MR imaging Positive - 14 patients), Group 2 (Bilateral MR imaging positive - 5 patients) and Group 3 (MR imaging negative - 10 patients). Patients suspected to be having MTS-based on clinical criteria/VEEG/SPECT findings with localization towards one side were included in the study. Group and individual comparisons were performed. Normal values were taken as Mean $\pm$ 2SD of the control group.

RESULTS

Glx/NAA ratio was significantly high in all the 3 groups on the ipsilateral side with significantly high side-to-side difference between 2 sides in all the 3 groups. Glx/Cr ratio was also significantly high in all 3 groups on the ipsilateral side but the side-to-side difference was not significant. The increase in (Cho+Cr)/NAA ratio was not significant in any of 3 groups. In Group 1, Glx/NAA, Glx/Cr and (Cho+Cr)/NAA ratios were increased on ipsilateral side only in 7, 5, and 6 patients, respectively. By combining the 3 ratios, 11 patients had increase in 1 or more ratios on the ipsilateral side. Increased side-to-side difference in Glx/NAA, Glx/Cr and (Cho+Cr)/NAA ratios were seen in 13, 5, and 6 patients, respectively. In Group 2, 2 patients each had increased Glx/NAA ratio on the ipsilateral side only and on both sides. Glx/Cr ratio was increased on ipsilateral and contralateral side in 3 and 1 patient, respectively. (Cho+Cr)/NAA ratio was increased in ipsilateral, contralateral and both sides in 1 patient each. Increased side-to-side difference in Glx/NAA, Glx/Cr, and (Cho+Cr)/NAA were seen in 5, 2, and 1 patients, respectively. In Group 3, Glx/NAA ratio was increased in 7, 1, and 1 patients on ipsilateral, contralateral, and both sides, respectively. Glx/Cr ratio was increased in 4, 1, and 2 patients on ipsilateral, contralateral, and both sides, respectively. Increased side-to-side difference in Glx/NAA, Glx/Cr, and (Cho+Cr)/NAA were seen in 9, 3, and 0 patients, respectively.

CONCLUSION

Glx/NAA ratio and its side-to-side difference are the most useful parameters in lateralization of side of seizure in unilateral as well as bilateral MR imaging positive as well as MR imaging negative patients of mesial temporal sclerosis.

KEY WORDS: Spectroscopy, epilepsy, glutamate

Paper 97 Starting at 10:39 AM, Ending at 10:47 AM**Diffusion-Weighted Imaging of a Focal Lesion in the Splenium of the Corpus Callosum: Is the Cause Seizures or Medications?**

Moritani, T. • Hiwatashi, A. • Ketonen, L. • Wang, H. • Ekholm, S. • Westesson, P.

University of Rochester
Rochester, NY

PURPOSE

To evaluate diffusion-weighted imaging (DWI) findings of focal lesions in the splenium of the corpus callosum in epileptic patients and correlate with clinical, electroencephalogram (EEG), and other MR findings.

MATERIALS & METHODS

We reviewed DWI findings of focal lesions in the splenium of the corpus callosum in 7 patients (9 to 79 years old, mean 33 years old, 3 male and 4 female). Two patients had intractable epilepsy with multiple antiepileptic medications. Three patients had seizures or subclinical seizures associated with headache, confusion, weakness, or speech disturbance with or without previous antiepileptic medications. One patient had a hemolytic uremic syndrome with generalized tonic-clonic seizure. One patient had a tacrolimus-induced myelinolysis after liver transplant. Electroencephalogram was performed in 5 patients. Diffusion-weighted imaging and apparent diffusion coefficient (ADC) maps ($b = 0, 1000 \text{ sec/mm}^2$, 3 orthogonal orientations) were obtained. MR imaging included T1, T2 and gadolinium-enhanced T1-weighted, and fluid attenuated inversion recovery (FLAIR) images.

RESULTS

In 5 patients, initial DWI at 1 to 3 days after onset showed a hyperintense round or oval lesion with decreased ADC in the splenium of the corpus callosum. In 2 patients, the initial DWI at 9 days and 4 months, respectively, showed a hyperintense round or oval lesion with increased ADC. On follow-up MR imaging at 3 months to 1 year, the areas of abnormalities on initial DWI were resolved completely in 2 patients and partially resolved in 1. Conventional MR imaging showed a nonhemorrhagic hyperintense lesion on T2-weighted and FLAIR images that was slightly hypointense on T1-weighted image. There was no enhancement after administration of IV gadolinium. Electroencephalogram showed an epileptic focus in 2 patients, slow waves in 2 patients, and was normal in 1 patient.

CONCLUSION

Round or oval DWI hyperintense lesion with decreased ADC were seen in the splenium of the corpus callosum. The cause of these focal lesions is thought to represent transient focal cytotoxic edema related to the transhemispheric connection with secondary generalized seizure activity, or toxic effect of medications or possibly other integrated mechanisms such as excitotoxic brain injury.

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KEY WORDS: Diffusion-weighted, epilepsy, corpus callosum

Paper 98 Starting at 10:47 AM, Ending at 10:52 AM**Transient Increased T2 Signal in the Splenium of the Corpus Callosum on Postictal MR Imaging**

Heaney, C. J. • Witte, R. J. • Campeau, N. G. • Watson, R. E. • Cohen-Gadol, A. A. • Marsh, R. W. • Britton, J. W. • Jack, C. R.

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PURPOSE

Reversible MR signal abnormalities in the splenium of the corpus callosum have been reported rarely in the literature in patients with epilepsy (1, 2) and in patients on antiepileptic medications (3). We report a case of reversible increased T2 signal in the corpus callosum postictally in a patient with refractory epilepsy.

MATERIALS & METHODS

A 27-year-old right-handed male with a long history of refractory partial epilepsy presented for evaluation. His neurologic examination was unremarkable. MR imaging was performed prior to evaluation. Medications included phenytoin (500 mg/day), valproic acid (2250 mg/day) and lamotrigine (400 mg/day). On admission the patient's medications were withheld for video-electroencephalography monitoring. Ictal Neurolite (Technetium Tc99m Bicisate) and interictal FDG-PET study were performed. MR imaging was performed 5 days following generalized tonic-clonic seizure. Follow-up MR exams were performed at 5 weeks and at 1 year.

RESULTS

MR imaging performed 4 months prior to examination was negative. MR imaging performed 5 days postsecondary generalized tonic-clonic seizure demonstrated a 1.4-cm unenhancing nonhemorrhagic ovoid lesion in the splenium of the corpus callosum with increased T2 signal. Ictal-interictal Neurolite-PET subtraction study indicated a right temporal focus for seizure activity. No perfusion abnormality was appreciated in the corpus callosum on the Neurolite examination. There was normal FDG uptake in the corpus callosum on the interictal study. Follow-up MR imaging at 5 weeks and 1 year demonstrated resolution of the signal abnormality in the corpus callosum.

CONCLUSION

Transient focal increased T2 signal in the corpus callosum can be seen in the setting of recent seizure activity. Such characteristic appearing signal abnormality remains of

uncertain etiology, but should be considered benign. Recognition and prompt diagnosis of this phenomenon will preclude unnecessary interventions.

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KEY WORDS: Corpus callosum, splenium, postictal

Paper 99 Starting at 10:52 AM, Ending at 11:00 AM

Hemispheric Involvement in Epileptic Patients: Value of Diffusion-Weighted Imaging

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Rochester, NY

PURPOSE

To evaluate diffusion-weighted imaging (DWI) findings of hemispheric involvement of ictal and postictal encephalopathy as compared with clinical, electroencephalogram (EEG) and other MR findings.

MATERIALS & METHODS

We reviewed DWI findings in 10 patients (1 day to 68 years old, mean 32 years old, 7 male and 3 female) with hemispheric involvement of ictal and postictal encephalopathy. Eight patients had status epilepticus and 2 had recurrent generalized seizures. Electroencephalogram was performed in all patients. Diffusion-weighted imaging and ADC maps ($b = 0, 1000 \text{ sec/mm}^2$, 3 orthogonal orientations) were obtained. Besides DWI, the MR examination included T1, T2 and Gd-enhanced T1-weighted, and fluid-attenuated inversion recovery images, as well as MR angiography. Initial DWI was obtained 6 hours to 18 days after onset of seizures. In 6 patients, follow-up MR images including DWI were obtained at 1 week to 2 years after initial DWI.

RESULTS

On MR imaging, including DWI, hemispheric involvement was seen on the right side in 6 patients and on the left in 4 patients. Entire hemispheric involvement was seen in 5 patients. The frontal area was spared partially in 5 patients. Ipsilateral involvement in the thalamus (6 patients), basal ganglia (2 patients) and hippocampus (4 patients), and the contralateral cerebellum (crossed cerebellar diaschisis) (1 patient) also were seen. In 7 patients DWI at the acute to early subacute phase showed these lesions as hyperintense with decreased ADC, which represents cytotoxic edema. Diffusion-weighted imaging more clearly demonstrated the distribution and extent of the lesions than conventional MR sequences in these patients. In the other 3 patients, DWI in the late subacute phase showed these lesions as slightly

hyperintense with increased ADC, which was seen on conventional MR imaging. Diffuse gyral enhancement was seen in these lesions in the subacute phase. MR angiography showed dilatation of arteries in the involved hemisphere in 2 patients. Electroencephalogram showed patterns of hemispheric neuronal dysfunction and diffuse asymmetric encephalopathy in all patients. On follow-up MR imaging, the areas of abnormalities on initial DWI were partially reversible but various amounts of cortical laminar necrosis, gliosis, and hemispheric atrophy were seen.

CONCLUSION

Diffusion-weighted imaging is useful for early detection of distribution and extent of involvement in patients with hemispheric ictal and postictal encephalopathy. Diffusion-weighted imaging is thought to be useful in predicting patient outcome. The areas of DWI abnormalities were partially reversible with various amounts of cortical laminar necrosis, gliosis, and hemispheric atrophy.

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KEY WORDS: Diffusion-weighted, epilepsy, cerebral hemisphere

Paper 100 Starting at 11:00 AM, Ending at 11:08 AM

T2 Relaxometry in the Evaluation of Patients with Mesial Temporal Lobe Epilepsy

Gaikwad, S. B. • Kanodia, A. K. • Mishra, N. K. • Garg, A. • Tripathi, M. • Padma, M. V. • Gupta, V. • Gupta, A. • Sharma, M. C.

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PURPOSE

To evaluate hippocampal T2 relaxation times in MR imaging positive and MR imaging negative patients of mesial temporal lobe epilepsy.

MATERIALS & METHODS

We performed T2 relaxometry in 8 controls (22-37 years, 5 males and 3 females), 23 patients of mesial temporal lobe epilepsy (age 8-43 years, 20 males and 3 females) with duration of epilepsy from 1-23 years (mean-9.6 years). Patients were divided in 3 groups: Group 1 (unilateral MR imaging positive included 14 patients), Group 2 (Bilateral MR imaging positive included 4 patients) and Group 3 (MR imaging negative included 11 patients). We used 16 echo CPMG (Carr-Purcell - Meiboom - Gill) sequence with TE from 22 ms to 352 ms.

RESULTS

In control patients, mean T2 relaxation time of 109.7 ms was seen (range 103-115 ms) with mean side-side variation of 3.32 ms (SD 1.82 ms). In group comparisons, significantly high T2 relaxation times were seen in ipsilateral side in Group 1 and 2 (head, body, and tail) and on contralateral side in Group 1 (body and tail) and Group 2 (head, body, and tail). Increase on ipsilateral side was more than contralateral side ($p < 0.01$). Increase in T2 relaxation times in Group 3 was not significant on either side. In Group 1, all patients had increased T2 relaxation time on ipsilateral side, while 9 patients also had increased T2 relaxation time on contralateral side. In Group 2, T2 relaxation times were increased on both sides in all patients. In Group 3, 2 patients had increased T2 relaxation time on ipsilateral side and 2 patients had raised T2 relaxation time on both sides (ipsilateral $>$ contralateral). In 1 patient T2 relaxation time was increased on contralateral side only.

CONCLUSION

Abnormal T2 relaxation times can be demonstrated by T2 relaxometry in the normal side in some of the unilateral MR imaging positive patients. In bilateral MR imaging positive patients, it may be helpful in detecting the more abnormal side. In MR imaging negative cases, T2 relaxometry may be helpful in detecting and lateralizing hippocampal abnormalities in a few patients, although the sensitivity is low.

KEY WORDS: Relaxometry, hippocampus, epilepsy

Paper 101 Starting at 11:08 AM, Ending at 11:13 AM

Late-Onset Neuroaxonal Leukodystrophy with Spheroids: Neuroimaging Findings

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PURPOSE

Only a handful of reports have presented the neuroimaging findings of late-onset neuroaxonal leukodystrophy with spheroids (NALS). The purpose of this study is to describe the clinical and neuroimaging findings in a case of pathology-proven sporadic late-onset NALS.

MATERIALS & METHODS

The clinical observation, neuroimaging findings, and pathologic characteristics in a case of late-onset NALS are presented and reviewed.

RESULTS

A 46-year-old female with a history of mild diabetes mellitus presented with slowly progressive cognitive decline, gait disturbance, and seizure. Neurologically, severe dementia, bilateral pyramidal tract signs and retropulsion were observed. No family history of neurologic disorder was reported. On MR imaging, the T2 FSE, FLAIR and diffusion-weighted imaging, exhibited confluent regions of hyperintensity in the bilateral cerebral white matter including corpus callosum. The white matter involvement was primarily deep and subcortical. The ADC map showed hypointensity in the deep white matter regions. The subcortical lesions adjacent to the atria of the lateral ventricles were

hypointense on the T1-weighted images. The U-fibers, internal capsules, brainstem, and cerebellum were spared. There were multiple small cystic lesions in the white matter. No abnormal enhancement was seen. An extensive work-up was negative for metachromatic leukodystrophy, adrenoleukodystrophy, Krabbe's disease, cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy, multiple sclerosis, and postinfectious encephalomyelitis. A brain biopsy was performed as a possibility of CNS vasculitis was raised although the conventional cerebral angiogram was normal. The histopathologic studies revealed severe abnormality in the subcortical white matter, which showed prominent cystic cavitation, reactive astrocytic gliosis, loss of myelin, and numerous small eosinophilic neuroaxonal spheroids. No evidence of vasculitis, taunopathy, or synucleinopathy was identified. Therefore, the diagnosis of sporadic late-onset NALS was established. The late-onset NALS is a rare neurologic disease of unknown etiology, which is characterized by the neuropathologic findings of cerebral white matter degeneration along with abundant spheroid formation in axonal regions, gliosis, and vacuolation. Typically, it affects the second to fourth decade of life, and leads to severe progressive cognitive deterioration and motor impairment including loss of balance, gait disorder, and spasticity. Most of the cases have a family history with an autosomal dominant pattern of inheritance. Only several sporadic cases have been reported, including this case. The brain MR appearance is nonspecific, demonstrating T2-weighted hypersignal intensity in the fronto/parietal white matter. High diffusion-weighted imaging and low ADC area may be seen in white matter disease, reflecting disintegration of the myelin with reduced mobility of water molecules. Without a definite family history, the differential diagnosis is broad, including numerous white matter degenerative diseases. However, the small multiple cystic lesions along with the diffuse bilateral white matter signal abnormality could be a neuroimaging diagnostic feature.

CONCLUSION

This excerpt presents the neuroimaging findings of a pathology-proven case of late-onset NALS. The MR appearance is relatively nonspecific and includes frontal and fronto/parietal high T2-weighted signal changes with scattered small cystic foci in the cerebral white matter. However, increased awareness of the MR findings of the late-onset NALS is important to prompt the diagnosis of this rare neurologic disease.

KEY WORDS: Neuroaxonal leukodystrophy with spheroids, degenerative disease

Paper 102 Starting at 11:13 AM, Ending at 11:21 AM**Cerebral MR Imaging after 16 Hours of Normobaric Hypoxia: Signs of Vasogenic and Cytotoxic Edema**

Kallenberg, K.¹ • Christ, S.¹ • Mohr, A.¹ • Roukens, R.² • Menold, E.² • Steiner, T.³ • Bailey, D. M.⁴ • Bartsch, P.² • Knauth, M.¹

¹Georg-August University Medical Centre, Goettingen, GERMANY, ²University of Heidelberg, Heidelberg, GERMANY, ³University of Heidelberg, Goettingen, GERMANY, ⁴University of Glamorgan, Glamorgan, UNITED KINGDOM

PURPOSE

Acute mountain sickness (AMS) is defined as a combination of unspecific symptoms like headache, dizziness, nausea, sleep disturbances, weakness and anorexia occurring 4 - 8 hours after arrival at an altitude over 2500 m above sea level. The symptoms indicate central nervous system disturbances. The exact pathophysiology is not known yet. Hypoxaemia seems to play the most important role because there is high correlation between severity of symptoms and level of hypoxaemia. There has been a report of changes in T2 signal intensity in the splenium of the corpus callosum (SCC) of patients with AMS. Two underlying mechanisms are discussed: 1) increased permeability of the blood-brain barrier (BBB) with resulting vasogenic edema and 2) break-down of sodium/potassium-ATPase with consecutive cellular swelling (cytotoxic edema). The aim of our study was to identify cerebral changes and differentiate between vasogenic and cytotoxic edema.

MATERIALS & METHODS

Twenty-two healthy volunteers (age 21-29 years) were exposed to an FIO₂ of 0.12 [ambient pO₂ equivalent to an altitude of 4500 m (14,850 ft)] in a normobaric hypoxia chamber. AMS was assessed by clinical examination and questionnaire. After an exposure time of 16 hours MR imaging was performed while maintaining hypoxia by a face mask. Dual echo, diffusion-weighted and T1-3D sequences were performed identically before, under and 6 hours after exposure to the hypoxic environment. The T2 relaxation time (T2_{rt}) and apparent diffusion coefficient (ADC) were calculated and measured in similar regions of interest (ROI). Volumetric data from T1-3D were obtained.

RESULTS

Eleven of the 22 subjects developed acute mountain sickness. Volumetry: Under hypoxic exposure a significant increase in total brain volume was observed ($p < 0.001$), which did not completely normalize to preexposure values after 6 hours. No significant relation between the absolute brain volume changes and severity of AMS was found. T2-relaxation time: Under hypoxic exposure a significant T2-prolongation was found in the SCC ($p = 0.0005$), which also did not normalize completely to preexposure values. ADC values: No increase in ADC values was observed under hypoxic exposure. However in posthypoxic MR imaging a significant decrease in ADC in the SCC was found ($p = 0.005$).

CONCLUSION

Under hypoxia an increase in total brain volume was found. In the SCC changes of T2 relaxation values and water-diffusibility was measured. While the increase and the rapid decrease of the T2 values may be caused by transient vasogenic edema, the decreased ADC values in the posterior part of the corpus callosum may reflect cytotoxic edema. It is unclear why the splenium of the corpus callosum seems to be a predilection site for these changes. However, the vulnerability of this structure in high-altitude cerebral edema has been described before. It is not yet clear, how the described changes relate to the clinical symptoms of AMS.

KEY WORDS: Hypoxia, MR imaging, acute mountain sickness

Paper 103 Starting at 11:21 AM, Ending at 11:28 AM**Conversion to Multiple Sclerosis after a Clinically Isolated Syndrome: Differences Depending on the Topography**

Rovira, A. • Tintoré, M. • Gispert, S. • Grivé, E. • Pericot, I. • Nos, C. • Sánchez, E. • Montalban, X.

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PURPOSE

In many cases, a clinically isolated syndrome (CIS) of the brainstem, optic nerve, spinal cord, or several regions, is the presenting attack of multiple sclerosis (MS). The conversion to MS (i.e., occurrence of a second attack) has been shown to be related to the results of paraclinical tests such as brain MR imaging and CSF analysis. The aim of this study was to compare the rates of conversion to clinically definite MS (CDMS) among the various topographical clinical syndromes at presentation, depending on the initial brain MR findings.

MATERIALS & METHODS

We studied 380 consecutive patients presenting with a CIS: 148 (39%) with optic neuritis, 99 (26%) with brainstem syndrome, 99 (26%) with spinal cord syndrome, and 34 (9%) with a polyregional syndrome. Mean clinical follow-up was 31 $\pm$ 22 months. The rates of conversion to clinically definite MS among the different clinical syndromes were compared. In a subgroup of patients, baseline ($n = 280$) and 1 year ($n = 229$) brain MR scans were obtained and the criteria for dissemination in space (at least 3 of the Barkhof criteria) and time (new T2 lesion on the follow-up MR exam) according to the McDonald criteria were assessed.

RESULTS

The rate of conversion to clinically definite MS in patients with optic neuritis was lower than that in polyregional syndromes (22% vs 40%; $p = 0.031$), brainstem syndromes (34%; $p = 0.043$) or spinal cord syndromes (34%; $p = 0.042$). Patients presenting with optic neuritis showed a lower rate of dissemination in space as compared to brainstem syndromes (29% vs 51%; $p = 0.003$) and polyregional syndromes (50%; $p = 0.042$), and a lower rate of dissemination in time (31%) as compared to spinal cord syndromes (52%; $p = 0.008$), brainstem syndromes (55%; $p = 0.004$) or polyregional syndromes (60%; $p = 0.015$). These differences disappeared when analyzing only the patients with an abnormal baseline MR exam (presence of at least one subclinical T2 focal brain lesion of the type seen in MS).

CONCLUSION

Patients presenting with optic neuritis showed a higher percentage of normal brain MR exams at presentation and a lower rate of conversion to clinically definite MS as compared to the other types of CIS. When the baseline MR exam demonstrated subclinical events, however, there were no significant differences among the various clinical groups with respect to the rate of conversion to MS. These results support the prognostic value of baseline MR imaging in CIS patients.

KEY WORDS: Multiple sclerosis, brain, MR imaging

Paper 104 Starting at 11:28 AM, Ending at 11:36 AM**Increased Intracranial Volume Suggests "Idiopathic" Normal Pressure Hydrocephalus Starts as Benign External Hydrocephalus in Infancy**

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University of California San Diego
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PURPOSE

Normal pressure hydrocephalus (NPH) was described initially as "idiopathic." It is diagnosed on the basis of a clinical triad of gait disturbance, dementia, and incontinence in elderly patients presenting with the radiographic picture of communicating hydrocephalus. Phase contrast CSF velocity imaging has been shown to be useful in selecting which patients will respond favorably to ventricular shunting. Specifically, the volume of CSF pulsating back and forth through the aqueduct over the cardiac cycle ["aqueductal CSF stroke volume" (SV)] is increased. A few years ago, it was suggested that NPH actually begins in infancy as "benign external hydrocephalus," a condition in which the CSF resorptive capacity is decreased, supposedly due to delayed maturation of the arachnoid villi. Since these children are less than 1 year old, their sutures can still expand, thus CSF accumulates in the subarachnoid space over the frontal convexities as well as within slightly enlarged ventricles, causing the children to present with increasing head circumference. If NPH patients truly did have benign external hydrocephalus as infants, they should have greater intracranial volumes than age- and sex-matched controls thereafter. Evaluation of that hypothesis was the purpose of this study

MATERIALS & METHODS

All patients with CSF velocity imaging studies for clinically suspected NPH over the prior 2 years were reviewed retrospectively. Only those with SVs 50% higher than normal were included in this study. The intracranial volumes of NPH patients and controls were measured from the T2-weighted imaging on a workstation. The mean SV for the NPH males was 149 uL; for NPH females it was 127 uL (compared to a normal literature value of 42 uL).

RESULTS

The average intracranial volume for NPH men was 1690 ml (n = 18), compared to 1584 for male controls (n = 26). The NPH volume averaged 100 cc (6.6%) larger than the control volume which was statistically significant (p = .03). The average intracranial volume for NPH women (n = 25) was 1495 ml, compared to 1407 for female controls (n = 56). The NPH volumes averaged 88 ml (6.3%) larger than the control volume and this was again statistically significant (p = .003).

CONCLUSION

This study shows that NPH patients have intracranial volumes 90-100 ml or 6% larger than age- and sex-matched controls. The larger volume confirms that the initial insult occurred before the sutures fuse at 1 year of age, as would be the case with benign external hydrocephalus. This would imply that the CSF resorption always has been decreased, not just when it is discovered in old age. The patients somehow remain asymptomatic until their later years when deep white matter ischemia leads to a second insult which could be increased periventricular ischemia, decreased CSF resorption via the extracellular space, or softening of the brain. The "second hit" leads to the symptoms of NPH. Radiologists probably see the CT and MR studies of "pre-NPH" patients routinely and dismiss the mild ventricular enlargement as "ventricles at the upper limits of normal." These patients should be observed for early signs of a gait disturbance in their elderly years as NPH develops.

KEY WORDS: Hydrocephalus, normal pressure hydrocephalus, dementia

Paper 105 Starting at 11:36 AM, Ending at 11:44 AM**Measurement of "Temporal Stem" for Diagnosis of Frontotemporal Dementia: Simple Method at Routine MR Imaging**

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PURPOSE

To determine whether frontotemporal dementia (FTD) can be differentiated from normal subjects and Alzheimer's disease (AD) by measurement of thickness of several limbic structures on routine MR examination.

MATERIALS & METHODS

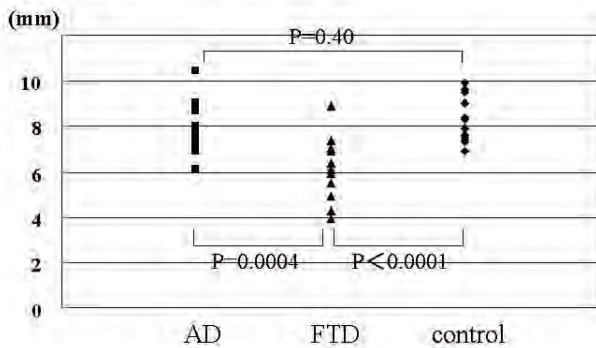
Forty-one patients with dementia (16 FTD and 25 AD) underwent MR studies at a 1.5 T MR imager. Study protocol includes axial and sagittal T1-weighted images, and axial and oblique coronal (parallel to the clivus) T2-weighted images. The diagnosis of dementia was established by two experienced psychiatrists using standard clinical criteria. Patients' mean age was 72.4 years (age range of 52-86 years). Fifteen age-matched controls also underwent MR examination with the same protocol for comparison. Width of the corpus callosum (anterior trunk), cingulate gyri, head of the hippocampi, and "temporal stem" of the anterior temporal lobes were measured, and compared among FTD, AD, and normal subjects. The "temporal stem," which includes the uncinate fasciculus as the commissural fiber between the frontal lobe and temporal pole, was defined as width between the inferior Sylvian fissure and inferior horn of the lateral ventricle at the slice of the head of hippocampus on oblique coronal T2-weighted images.

RESULTS

The width of the temporal stem of FTD (6.3 ± 1.3 mm) was significantly smaller than those of control subjects and patients with AD (7.8 ± 1.1 mm, p = 0.0013), although there were some overlaps between AD and FTD. All patients with

the temporal stem width of less than 5 mm were FTD. The widths of the corpus callosum, cingulate gyri, and hippocampi of AD and FTD were significantly smaller than those of control subjects, but there were no significant differences between AD and FTD.

Table 1 Comparison of width of "temporal stem" on oblique-coronal MR images among AD, FTD and control subjects



CONCLUSION

The width of the "temporal stem" was significantly smaller for FTD than for control subjects and AD. This measurement is easy and simple, and may be useful for diagnosis of FTD.

KEY WORDS: Dementia, MR imaging

Tuesday Morning

10:15 AM - 11:45 AM
Ballroom 6 A

(23b) Head & Neck General
(Scientific Papers 106 - 117)

See also Parallel Sessions

(23a) Adult Brain: Epilepsy

(23c) Pediatrics: General, Functional, and Vascular Imaging

(23d) Pediatrics: General and Leukoencephalopathy

Moderators: Jane L. Weissman, MD
R. Nick Bryan, MD, PhD

Paper 106 Starting at 10:15 AM, Ending at 10:23 AM

High-Resolution MR Imaging of the Human Eye

Bert, R. J.¹ • Patz, S.^{1,2} • Ossiani, M.¹ • Freddo, T.^{3,4,5}

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PURPOSE

To develop a low-cost, consistent technique of imaging the small structures of the anterior chamber of the human eye for commercial 1.5 T magnets, that minimizes motion and susceptibility artifacts. Our intention was to image at 200-250 micron in-plane resolution.

MATERIALS & METHODS

IRB approval for the study was obtained. After complete eye examinations, 8 normal male and 3 normal female volunteers were imaged (ages 27-52 years) on 1.5 T systems by three major suppliers (Philips, GE, and Siemens). Commercially available circular or near circular surface receiver coils (TMJ coils) were used for image acquisition. Patient preparation made use of conjugate-gaze of the eye, such that a single closed eye was imaged while the remaining open eye fixated on a cross-hair target. The closed eye was gently taped shut and covered with soaked 2 x 2 gauze pads. Several imaging sequences were explored for optimum visualization of the fine structure of the anterior chamber: T1-weighted and T2-weighted conventional and turbo spin-echo, T1-weighted gradient echo MR imaging with crusher gradients, MPRAGE without an inversion pulse, T1 and T2 FLAIR. Imaging time was typically 4-5 minutes.

RESULTS

All three commercially available systems were capable of imaging the small structures of the anterior chamber of the eye at 200-250 micron resolution. T1-weighted conventional spin-echo images (e.g., TR/TE/FA/SA = 400/17/ 90/6, in-plane-resolution 250 micron x 250 micron pixel size; 3 mm slices, image time = 4.3 min.), gave consistent images with good contrast-to-noise ratios on all systems. Long echo-time T2-weighted images benefited by applying a first order motion compensation gradient pulse. TSE sequences were of similar C/N, but were judged subjectively to be of slightly less quality. Gradient-echo sequences, especially MPRAGE 3D acquisition, provided the best overall C/N. Including a vitamin E tablet at the corner of the conjunctiva appeared to improve S/N of the fine structures for one particular coil.

CONCLUSION

1. Two hundred to 250 micron resolution images of the anterior chamber of the eye are obtainable with 1.5 T commercially available systems. 2. The iris, ciliary bodies, anterior chamber, posterior chamber, lens and lens capsule and retina are imaged clearly using this technique. 3. This technique for imaging the anterior eye might be useful for glaucoma research and evaluation of other anterior ophthalmic disease states.

KEY WORDS: High-resolution imaging, globe, fine structure

Paper 107 Starting at 10:23 AM, Ending at 10:31 AM**Nerve Sheath Tumors of the Carotid Space: Imaging Findings in 15 Cases**

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PURPOSE

The radiographic characteristics of many carotid space masses allow a radiologic diagnosis to be made with appropriate imaging studies. We report the imaging findings of a relatively large series of nerve sheath tumors of the carotid space, reviewing their clinical presentation as well as their characteristic radiologic appearance.

MATERIALS & METHODS

CT, MR imaging, and angiographic studies of 15 histologically proven carotid space nerve sheath tumors (neurofibromas and schwannomas) were reviewed retrospectively according to their demographics, imaging characteristics, and surgical pathologic results.

RESULTS

Surgery on the 15 carotid space masses confirmed the presence of 7 schwannomas, 7 neurofibromas, and 1 malignant peripheral nerve sheath tumor. Ten patients had a contrasted CT performed prior to surgery, 6 had contrasted MR imaging, and 4 had an angiography study performed preoperatively. The neurofibromas cases demonstrated low density and lack of enhancement by CT, with variable signal intensity but gadolinium enhancement on contrasted MR imaging. The schwannoma cases demonstrated enhancement by both CT and MR imaging, with heterogeneous density and signal intensity characteristics, and had variable angiographic patterns ranging from peripheral to central opacification. One schwannoma case was found histopathologically to be melanotic, and demonstrated central foci of increased T1 signal intensity on MR imaging. An outlying lesion was found to be a malignant peripheral nerve sheath tumor, and demonstrated low density on CT, with surrounding rim enhancement following contrast administration.

CONCLUSION

With attention to CT, MR imaging, and enhancement features, the histology of nerve sheath tumors of the carotid space often can be predicted based solely on the imaging characteristics. This presentation will focus on the salient anatomy of the carotid space, imaging characteristics of these lesions, and relevant clinical issues.

KEY WORDS: Carotid space, nerve sheath tumor

Paper 108 Starting at 10:31 AM, Ending at 10:39 AM**Radiologic Features of Osteoradionecrosis of the Mandible**

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PURPOSE

To illustrate the typical presentation, natural history, and salient radiologic features of osteoradionecrosis of the mandible (ORNM) in patients who undergo radiation therapy for head and neck cancer.

MATERIALS & METHODS

Five patients with cancer of the oral cavity/oropharynx who developed histopathologically proven ORNM following radiation therapy. Available CT and MR scans were reviewed retrospectively. Clinical data, operative findings, and pathologic features were correlated with the evolution of findings over serial scans.

RESULTS

The bony abnormalities involved the body of the mandible in all five cases. Five of five patients had ill-defined cortical disruption/destruction. Five of five had internal architectural (trabecular) distortion of the medullary bone. Three of five patients had infiltrative changes in the surrounding soft tissues which were detected by MR imaging only early on and later evident on CT as ORNM progressed. Three patients had a pathologic fracture of the mandible and one patient had a radiologically demonstrable orocutaneous fistula.

CONCLUSION

Radiologic features of ORNM include ill-defined cortical disruption, trabecular distortion of medullary bone with possible progression to pathologic fracture and/or adjacent soft tissue changes. Soft tissue changes associated with ORNM are detected earlier on MR imaging than CT and do not necessarily represent tumor recurrence when found in the context of mandibular osseous abnormality. Therefore, the diagnosis of ORNM also should be considered in these patients. Knowing the evolution of radiographic findings of ORNM may help in the diagnosis of clinically suspected ORNM.

KEY WORDS: Osteoradionecrosis, mandible, imaging

Paper 109 Starting at 10:39 AM, Ending at 10:47 AM**Cranial Nerve Palsy in Nasopharyngeal Carcinoma: MR Imaging/Clinical Correlation**

Kan, W. • Lau, K. • Chan, J. • Sze, W. • Lee, A. • Yau, T. • Yeung, R. • Lee, A.

Pamela Youde Nethersole Eastern Hospital
Hong Kong, HONG KONG SPECIAL ADMINISTRATIVE
REGION OF CHINA

PURPOSE

To evaluate the accuracy of detection of cranial nerve involvement by MR imaging in nasopharyngeal carcinoma (NPC) and correlate with their clinical presentation.

MATERIALS & METHODS

From 18.08.1998 to 7.11.2002, 96 patients with newly diagnosed NPC (histologically proven) were reviewed retrospectively. There were 72 males and 24 females, age ranged 17 - 83 years (mean = 51.36 years). In all patients, axial T1-, T2-weighted images with fat saturation; coronal T1, T2 with fat saturation and postgadolinium axial and coronal T1-weighted images with fat saturation were obtained through the nasopharynx using 1.5 T MR system (Signa, GE Medical Systems, Milwaukee, Wisconsin, USA or Symphony, Siemens Medical Systems, Erlangen, Germany). The MR evidence of cranial nerve involvement was noted by two qualified radiologists. The MR evidence of cranial nerve involvement was suggested by tumor involvement of the cavernous sinus or basal foramina, or perineural gadolinium enhancement. The number of cranial nerves with clinical evidence of palsy was noted by two qualified clinical oncologists. The number of cranial nerves with and without clinical evidence of cranial nerve palsy was correlated with the number of cranial nerves with MR evidence of cranial nerve involvement. None of these patients had history of neurologic symptoms or cranial nerve palsy prior to the presentation.

RESULTS

Among 16 cranial nerves with clinical evidence of palsy, 13 showed MR evidence and 3 showed no MR evidence of cranial nerve involvement. Among 103 cranial nerves with MR evidence of cranial nerve involvement, 13 showed clinical evidence and 90 showed no clinical evidence of cranial nerve palsy.

CONCLUSION

In view of the discrepancy of clinical and MR findings in cranial nerve palsy in NPC, correlation between clinical and MR findings is mandatory for assessment of cranial nerve involvement, which is important for prognosis and staging. We hypothesize the discrepancy between clinical and MR detection of cranial nerve palsy.

KEY WORDS: Nasopharyngeal carcinoma, cranial nerve palsy, correlation

Paper 110 Starting at 10:47 AM, Ending at 10:55 AM

Nasopharyngeal Carcinoma in Children: A Retrospective Case and Imaging Review

Krishnan, A. R. • Hudgins, P. A. • Wise, S.

Emory University School of Medicine
Atlanta, GA

PURPOSE

The purpose of this paper is to review a series of children, adolescents, and young adults with nasopharyngeal carcinoma, document the clinical presentations, and describe the imaging findings.

MATERIALS & METHODS

Retrospective reviewing of medical records and imaging from 9 cases. The following were documented: patient age at presentation, gender, ethnicity, symptoms at presentation, delay in diagnosis, initial pretreatment imaging findings, pathology results, and EBV serology.

RESULTS

Of the 9 cases reviewed, the ages of presentation ranged from 6 years to 19 years. Five were male and 4 were female. Eight were African American and 1 was Caucasian. Symptoms at presentation included epistaxis, nasal obstruction, hearing loss, facial pain/numbness, and neck mass. Pretreatment imaging findings included nasopharyngeal masses with local soft tissue extension, skull base erosion, enhancement of involved cranial nerves, and cervical adenopathy. Delay in diagnosis from the initial clinic visit to diagnosis by imaging or physical exam ranged from 5 weeks to 8 months. In all cases, pathology demonstrated poorly differentiated or undifferentiated nasopharyngeal carcinoma. EBV serology was positive in 6 cases and unavailable in 3 cases.

CONCLUSION

Nasopharyngeal carcinoma is an uncommon neoplasm in childhood and adolescence, but does occur. Based on this case series in the native population in the United States, these neoplasms occur more commonly in African males who often present with symptoms related to eustachian tube obstruction, nasal obstruction, or adenopathy. A delay in diagnosis is not uncommon due to the nonspecificity of the symptoms and lack of objective findings on physical exam. Therefore, local extension of neoplasm with skull base erosion and/or adenopathy is found often on initial imaging.

KEY WORDS: Nasopharyngeal, carcinoma, children

Paper 111 Starting at 10:55 AM, Ending at 11:03 AM

Cervical Thymus: Imaging Features and Management Implications

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Children's National Medical Center
Washington, DC

PURPOSE

Ectopic presence of thymus in neck is an unusual cause of neck mass in children and may pose a diagnostic challenge. The purpose of this presentation is to discuss the diagnostic features and clinical management of the cervical thymus.

MATERIALS & METHODS

Five cases of cervical thymus encountered over the past 8 years at our institution.

RESULTS

At the time of detection, one patient was 3 years old and the remaining four children were less than 1 year old. In 3 patients, the referral clinical diagnosis was neck mass and in the other 2 patients, the cervical thymus was an incidental finding. In all cases, the cervical thymus demonstrated features on CT and/or MR imaging similar to mediastinal thymus. In two cases, the diagnosis of ectopic cervical thymus was established by imaging by demonstrating the communication between the cervical mass and the mediastinal thymus. In two cases, the diagnosis was confirmed surgically as no communication was demonstrated by imaging between the cervical mass and the mediastinal thymus. In one case with isolated cervical thymus, follow-up studies over the next few years demonstrated spontaneous involution of the mass. All lesions were located in parapharyngeal and/or sub-

mandibular region and closely associated with the course of carotid artery. In two of the cases, tortuosity and displacement of the carotid artery adjacent to the ectopic thymus were noted. Two of the patients had bilateral ectopic thymus.

CONCLUSION

Imaging features of cervical thymus per se may not allow confident nonsurgical diagnosis in all cases in the absence of communication between the cervical mass and the mediastinal thymus. The possibility of ectopic thymus should be included in the differential diagnosis of a parapharyngeal or submandibular mass in a child, if the mass demonstrates MR imaging signal intensity and/or CT density identical to mediastinal thymus. Theoretically, it also would be important to establish presence of additional mediastinal thymus prior to surgery for a cervical mass with diagnostic features suggestive of cervical thymus if there is plan for complete surgical resection of a suspicious neck mass in an infant.

KEY WORDS: Cervical thymus, ectopic thymus, neck mass

Paper 112 Starting at 11:03 AM, Ending at 11:11 AM

High-Resolution Three-Dimensional MR Imaging of Sudden Hearing Loss and Meniere Syndrome

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¹Radiodiagnostic Unit I, Florence, ITALY, ²University of Florence, Florence, ITALY

PURPOSE

To evaluate the role of high-resolution MR imaging in patients with sudden hearing loss and Meniere syndrome.

MATERIALS & METHODS

From January 2002 to December 2003 we studied 110 consecutive patients: 90 with sudden hearing loss and 20 with Meniere syndrome. All patients had a complete clinical and instrumental examination on both ears. In each case we performed high-resolution MR imaging with 1.5 T machine using T2 3D reverse linear 0.5 mm and TSE T2 turbo drive 0.5 mm thickness sequence in order to have the best contrast between inner ear structures and surrounding parenchyma. We performed also a complete examination of the brain and we injected also Gd-DTPA to investigate further the inner ear. We measure the distance between the posterior semicircular canal and the posterior edge of temporal bone on both sequences and on both sides. We acquire also the same distance in a control population (value = 3.00 mm +/-1.2 mm). All examinations were reviewed by two independent neuro-radiologist.

RESULTS

The distance was reduced in 11 cases of Meniere syndrome on the affected side (value 1.8 mm) and in 4 patients with sudden hearing loss (2.1 mm). Two of them developed a complete Meniere syndrome 1 month later. The measurements were exactly the same on both sequences used. We also found 11 acoustic neurinoma situated entirely inside the internal acoustic canal on the affected side. In 3 cases we also found enhancement of the nerves in the fundus of internal acoustica canal.

CONCLUSION

The protocol we used in case of patients with sudden hearing loss was able to detect many causes of the symptoms. The two high-resolution sequences used showed the same information despite the different times of acquisition (8' for reverse linear and 4' for turbo drive). The finding of reduced distance in patients with sudden hearing loss may be a predictive role for Meniere syndrome.

KEY WORDS: High-resolution 3D MR, sudden hearing loss, Meniere syndrome

Paper 113 Starting at 11:11 AM, Ending at 11:19 AM

Facial Nerve Schwannomas of the Internal Auditory Canal: A Critical Acoustic Schwannoma Mimic

Gupta, A. S. • Wiggins, R. H. • Salzman, K. L. • Harnsberger, H. R. • Shelton, C.

University of Utah
Salt Lake City, UT

PURPOSE

When a facial nerve schwannoma (FNS) is centered in the cerebellopontine angle (CPA) or internal auditory canal (IAC), it often mimics the far more common acoustic schwannoma (AS). It is critical to differentiate FNS from AS preoperatively as there are important management and prognostic implications. The principle focus of this study is to identify differentiating clinical and imaging features of the rare, but important IAC facial nerve schwannoma compared to acoustic schwannoma.

MATERIALS & METHODS

Twenty-eight patients with facial nerve schwannoma evaluated at our institution over a 15-year period were reviewed retrospectively. Fourteen of the 28 patients had significant IAC involvement of the FNS and were segregated. Clinical data was collected including age, gender, facial nerve neuropathy, hearing loss and tinnitus. MR imaging studies in all cases were evaluated for location of the mass and extension along the facial nerve. Each segment of the facial nerve was evaluated for possible tumor involvement. CT images were evaluated for enlargement of the facial nerve canal. Histopathologic results were confirmed on all operated cases. Follow-up imaging was reviewed in the remaining cases.

RESULTS

Fourteen patients with the diagnosis of FNS and significant IAC involvement were reviewed. The patients ranged in age from 10 to 68 years with a mean of 40.2 years. There were 7 male and 7 female patients. Five patients had facial nerve symptoms while 8/14 patients presented with sensorineural hearing loss. MR showed enhancement along the labyrinthine segment in 13/14 patients. In the eleven cases in which a CT was performed, the facial nerve canal was enlarged in ten patients. Surgical and histopathologic correlation was available in 10/14 patients.

CONCLUSION

Facial nerve schwannoma can be differentiated from acoustic schwannoma by MR imaging if there is enhancement along the course of the facial nerve. Specifically, enlargement of the facial nerve canal and an enhancing

“labyrinthine tail” are the important distinguishing imaging features. Clinical symptoms were less useful in differentiating FNS from AS. Surprisingly, sensorineural hearing loss is a more common presenting symptom in FNS than facial neuropathy. Symptoms referable to the facial nerve are seen in a minority of FNS patients.

KEY WORDS: Facial nerve schwannoma, acoustic neuroma, IAC mass

Paper 114 Starting at 11:19 AM, Ending at 11:27 AM

MR Imaging of Head and Neck Plexiform Neurofibromas in Neurofibromatosis Type 1: A Review of 67 Patients

Zacharia, T. T.¹ • Poussaint, T. Y.² • Jaramillo, D.¹ • Korf, B. R.³

¹Massachusetts General Hospital, Boston, MA, ²Children's Hospital, Boston, MA, ³University of Alabama, Birmingham, AL

PURPOSE

To define the most prevalent patterns of involvement and MR imaging findings in head and neck plexiform neurofibromas in neurofibromatosis type 1.

MATERIALS & METHODS

We reviewed the MR appearance of head and neck lesions in 67 patients [32 males, 35 females; ages 5-70 years, pediatric (n = 41), adult (n = 26)] with neurofibromatosis type 1. The patients were part of a multiinstitutional study of the natural history of plexiform neurofibromas. All imaging included contiguous axial short tau inversion recovery images (TR/TE 6000/35; inversion time, 150 msec; echo-train length = 8), which were used for volumetric measurements.

RESULTS

The plexiform volumes ranged from 0.5 cc to 1450 cc with interobserver variability of ~10% (1). The most common head and neck involvement was the masticator space (n = 25), parapharyngeal space (n = 24), carotid space (n = 22) and brachial plexus (n = 21). Parotid gland involvement was noted in 25 patients and the submandibular gland was involved in 10 patients. In 13, the plexiform neurofibromas extended into the infratemporal fossa, and in 9 there was pterygopalatine fossa involvement. Scalp (n = 20), ear, and external auditory meatus (n = 10) and orbit (n = 7) involvement were frequent. Lingual neurofibromas were noted in 8 patients. Thyroid gland involvement was noted in 2 patients (involving one lobe in one and complete thyroid gland involvement in another). The lesions were hyperintense on T2 images and the target sign was present in more than half of the patients (2).

CONCLUSION

Head and neck plexiform neurofibromas in neurofibromatosis type 1 can affect multiple deep spaces of the neck. In our series the majority of patients were pediatric. Although lesions are most prevalent in the masticator space, parapharyngeal space, and brachial plexus, lingual and pterygopalatine fossa involvement may be seen. Salivary gland involvement was noted in more than half of the patients. The target sign was present in 50% of cases.

REFERENCES

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2. Iannicelli E, Rossi G, Almberger M, et al. **Integrated Imaging in Peripheral Nerve Lesions in Type 1 Neurofibromatosis.** *Radiol Med (Torino)* 2002;103:332-343

KEY WORDS: Plexiform neurofibroma, NF-1, head and neck

Paper 115 Starting at 11:27 AM, Ending at 11:32 AM

Teflon Granulomas in the Posterior Pharynx: False Positive Findings on Positron Emission Tomography Clarified with Fused Positron Emission Tomography/CT

Harrigal, C. L. • Snyderman, C. H. • Maroon, J. C. • Branstetter, B. F.

University of Pittsburgh Medical Center
Pittsburgh, PA

PURPOSE

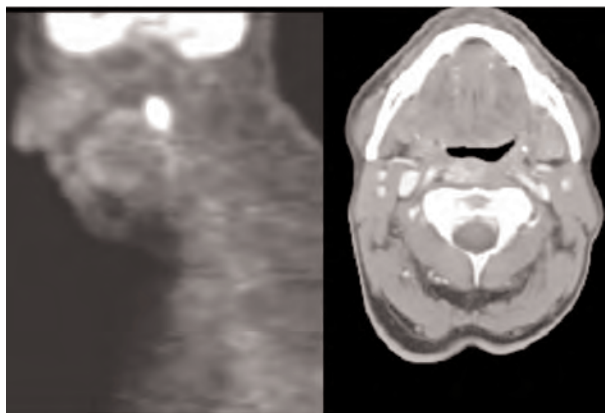
Positron emission tomography (PET) has become a crucial imaging modality in the diagnosis and staging of head and neck tumors. However, the lack of precise anatomical localization and the inability to characterize tissue anatomically increase the potential for false positive results. Sources of false positive PET include physiologic uptake and inflammatory or granulomatous reactions. The purpose of this report is to highlight two patients with surgically corrected velopharyngeal insufficiency (VPI) in whom focal PET uptake was interpreted incorrectly as squamous cell carcinoma (SCC). The findings were clarified with combined PET/CT and MR imaging.

MATERIALS & METHODS

Two different patients presented to us with clinical findings suggesting SCC of the posterior pharynx. PET was performed to confirm the presence of tumor, evaluate extent of disease, and exclude metastases. Initial PET images were suggestive of SCC, but further imaging (combined PET/CT in one patient and MR imaging in the other) were not consistent with SCC. A careful review of the patients' histories revealed pharyngeal Teflon injections for treatment of VPI. The diagnosis of Teflon-induced granuloma was made without the need for surgical intervention, and both patients were evaluated with close interval follow-up.

RESULTS

Positron emission tomography from patient #1 shows dramatic focal FDG uptake in the posterior pharynx (Fig 1). CT shows amorphous increased density more consistent with injected Teflon (Fig 2). Positron emission tomography from patient #2 was similar, but MR imaging showed decreased T2 signal, consistent with fibrosis rather than SCC. Both patients were followed radiographically for several months. The lesions remained stable in size and in imaging characteristics.



CONCLUSION

Teflon injections were used historically in many medical fields to supplement diseased tissue and restore physiologic function. For example, VPI, a swallowing disorder, has been treated with Teflon injections into the posterior pharynx to assist in the apposition of the pharynx with the palate and tongue. Unfortunately, Teflon injections in various tissues have demonstrated significant granulomatous reaction, with inflammation and eventual fibrosis. Thus, most Teflon injection techniques have been abandoned. However, these historical procedures still provide a potential source of false positive PET interpretations because the granulomatous tissue has marked FDG uptake. Fused PET/CT or MR imaging, in conjunction with a thorough patient history, can be used to decrease the risk of false positive PET interpretation and to correctly reach a diagnosis of Teflon granuloma without unnecessary medical intervention.

KEY WORDS: Teflon granuloma, velopharyngeal insufficiency, PET false positive

Paper 116 Starting at 11:32 AM, Ending at 11:37 AM

Fetal Rhabdomyoma Demonstrated by Prenatal MR Imaging

O'Callaghan, M. G. A. • House, M. • Bhadelia, R. A.

Tufts-New England Medical Center
Boston, MA

PURPOSE

We present a rare case of posterior triangle fetal rhabdomyoma detected by prenatal MR imaging. Postnatal evaluation and therapy are discussed.

MATERIALS & METHODS

Prenatal evaluation consisted of ultrasound and MR with T2 weighted ultra fast imaging. Postnatal evaluation was performed with contrast-enhanced MR imaging and CT followed by angiography and embolization. The patient was followed for 2 years postsurgery.

RESULTS

Fetal ultrasound demonstrated a mass of undetermined origin between placenta and fetal head. The fetal MR imaging demonstrated a mass with heterogeneous signal arising from the soft-tissues of the head and neck, and distinct from placenta. No associated intracranial abnormality or bony calvarial defect was present. The postnatal MR imaging demon-

strated a well circumscribed subcutaneous mass with multiple flow voids, and heterogeneous T2 signal, isointense T1 signal, and intense gadolinium enhancement. No underlying bony defect was seen on CT. Because of the vascular nature of the lesion preoperative embolization was performed on day 10. The vessels supplying the mass all arose from the left ECA. The arterial feeders were embolized utilizing 200 to 300 micron PVA particles. At 11 days of age excision of the mass was performed. Pathologic examination revealed tumor extending to the margin. The tumor recurred shortly afterwards and was resected again at 3 months of age. After 2 years of surveillance there was no further recurrence.

CONCLUSION

Although fetal rhabdomyoma is a rare head and neck tumor, it is important to consider this benign neoplasm in the differential diagnosis of head and neck masses on prenatal MR imaging.

KEY WORDS: Fetal, MR imaging, rhabdomyoma

Paper 117 Starting at 11:37 AM, Ending at 11:42 AM

Barotrauma Presenting as Temporal Lobe Injury Secondary to Temporal Bone Rupture

Cortes, M. D. P. • Nugent, R. A. • Longridge, N. S.

Vancouver General Hospital
Vancouver, BC, CANADA

PURPOSE

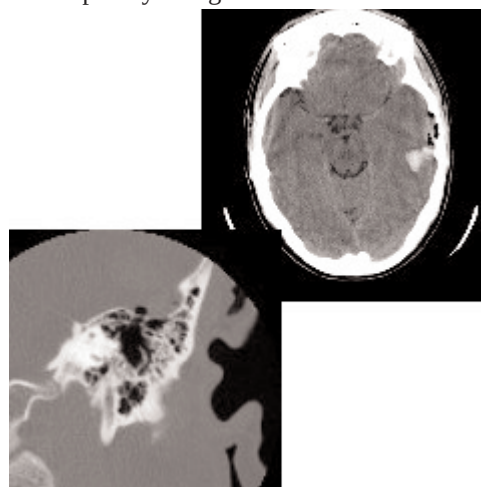
We wish to report the unique neuroimaging findings resulting from an uncontrolled scuba diving ascent.

MATERIALS & METHODS

A 31-year-old male developed acute left ear pain while ascending from 30-ft scuba dive. He continued to have severe otalgia while at the surface and also developed vertigo and decreased hearing. In emergency, he had no neurologic abnormality but his severe pain persisted despite analgesics, prompting a request for a CT scan.

RESULTS

The head CT revealed parenchymal hemorrhage and gas within temporal lobe overlying the petrous bone, as well as epidural blood and gas in the left middle fossa. No abnormality was seen in the temporal bone but bone could not be identified completely along the roof.



CONCLUSION

To our knowledge, this is the first report of a case with intracerebral hemorrhage and presumed temporal bone rupture resulting from barotrauma. A discussion of the mechanism and a brief review of intracranial complications of barotrauma will be provided.

KEY WORDS: Barotrauma, intracerebral hemorrhage, temporal bone

Tuesday Morning

10:15 AM - 11:56 AM
Room 606 - 609

(23c) Pediatrics: General, Functional,
and Vascular Imaging
(Scientific Papers 118 - 129)

See also Parallel Sessions

(23a) Adult Brain: Epilepsy

(23b) Head & Neck: General

(23d) Pediatrics: General and Leukoencephalopathy

Moderators: A. James Barkovich, MD
Jill V. Hunter, MD

Paper 118 Starting at 10:15 AM, Ending at 10:23 AM

Elevated Lactate as an Early Marker of Brain Injury in Inflicted Traumatic Brain Injury

Cecil, K. M. • Makoroff, K. L. • Ball, W. S. • Care, M. M.

Children's Hospital Medical Center
Cincinnati, OH

PURPOSE

The metabolic and neurochemical abnormalities that underlie traumatic brain injury remain poorly understood. This study aimed to evaluate children with inflicted traumatic brain injury using MR spectroscopy (MRS). We hypothesized that children with hypoxic-ischemic injury indicated by elevated lactate in the acute phase of injury will have worse short-term clinical outcomes than those without lactate upon MRS.

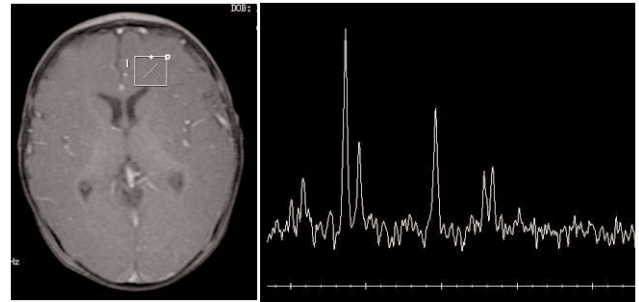
MATERIALS & METHODS

This study employed proton MRS to sample bilaterally the frontal lobes and the parasagittal cortex within the parietal and occipital lobes of patients (n = 11, 6 male) with inflicted traumatic brain injury undergoing a clinical MR examination. Patients measured clinical course while hospitalized included a neurologic evaluation with seizure activity noted,

admission to the pediatric intensive care unit (PICU), days hospitalized, presence of retinal hemorrhage and bone fractures. Measurement of outcome was determined using the Pediatric Overall Performance Category Scale (POPCS; 1 = good performance; 6 = death).

RESULTS

Four children demonstrated elevated lactate and diminished N-acetyl aspartate within several regions indicating global ischemic injury (lactate positive-global group). These four children all had early seizures, abnormal initial neurologic examinations and were admitted to the PICU. The mean POPCS for this group was 3.25. Four children had lactate detected within at least one region indicating a focal ischemic injury (lactate positive-focal group); two of these children had early seizures and two had an abnormal initial neurologic examination. The mean POPCS score was 1.5 for this group. The remaining three children had no evidence of lactate upon MRS (lactate negative group). These children did not have early seizures, require admission to the PICU, or have initial abnormal neurologic examinations. The mean POPCS score was 1.3 for this group.



CONCLUSION

Patients with inflicted traumatic brain injury and evidence of hypoxic-ischemic injury as indicated by elevated lactate on MRS tend to have worse early neurologic status and outcomes. Lactate levels as sampled by MRS may predict early clinical outcome in inflicted traumatic brain injury.

KEY WORDS: Inflicted traumatic brain injury, MR spectroscopy, outcomes

Paper 119 Starting at 10:23 AM, Ending at 10:31 AM

MR Venography in Infants and Children: Age-Related Changes and Variations of Normal

Rollins, N.¹ • Ison, C.¹ • Booth, T.¹ • Chia, J.²

¹Children's Medical Center, Dallas, TX, ²Philips Medical Systems, Dallas, TX

PURPOSE

To determine the normal appearance of posterior fossa venous sinuses and age-related differences in MR venography and to compare conspicuity of venous structures on 2D TOF MRV vs timed bolus injected gadolinium-enhanced 3D gradient-echo MRV (Gd 3D GE MRV) in infants and children.

MATERIALS & METHODS

One hundred seven patients, (ages newborn-17 years, mean 11.75 years) with seizures or developmental delay and normal MR findings or minimal congenital anomalies were studied using 2D TOF MR venography (23/5.1/50, TR/TE/flip angle). Eleven children were studied using both 2D TOF MRV and Gd 3D GE MRV [6.0/2.0/35, TR/TE/flip angle with over contiguous slices using segmented central k-space ordering (CENTRA)]. Maximum intensity projection (MIP) images were evaluated for transverse sinus dominance and visibility and presence of an occipital sinus. Conspicuity of the internal jugular veins and intracranial venous structures as seen by 2D TOF MRV were compared to that seen on Gd-enhanced 3D GE. The relationship between transverse sinus (TS) dominance and age was evaluated with Chi square contingency analysis and the relationship between transverse sinus atresia and age and occipital sinus involution with age using Chi square trend analysis.

RESULTS

In patients < 25 months of age, codominant TS were seen in 42%, right dominant TS in 37%, and left dominant TS in 21%. Saturation effects limited visualization of the TS in 52% of patients. Occipital sinuses were observed in 13% and TS atresia in 5%. Between 25 months-5 years, 35% had codominant TS, 35% right dominant TS, and 30% left dominant; 18% had TS atresia and 12% had occipital sinuses. Among patients 6-17 years, 34% had codominant TS, 50% right dominant TS and 16% left dominant, 13% had an atretic TS and 2% had persistent occipital sinus. Conspicuity of the intracranial venous sinuses on the Gd 3D MRV was judged equal to or better than on the 2D TOF MRV in 11/11 patients. Visualization of the IJV was better on the 3D MRV than the 2D TOF MRV in 5 patients, comparable in 4 patients, and of lesser quality on the 3 D MRV in 2 patients.

CONCLUSION

Age-related changes in posterior fossa venous anatomy include increasing frequency of right transverse sinus dominance with age ($p = 0.026$), involution of occipital sinuses ($p = 0.038$), and increasing frequency of transverse sinus atresia. Caution should be used before the diagnosis of posterior fossa venous occlusive disease is made especially in neonates and young infants on the basis of signal loss when using 2D TOF MRV. Gadolinium-enhanced 3D MRV provides superior delineation of venous structures and may be needed to clarify posterior fossa and internal jugular venous anatomy in some patients.

KEY WORDS: MR venography, pediatrics

Paper 120 Starting at 10:31 AM, Ending at 10:39 AM

Integration of MR Perfusion Abnormalities and Cerebral Vascular Reactivity Changes in Patients with Moyamoya Disease

Kassner, A.¹ • Crawley, A.¹ • Rowan, S.² • Roberts, T. P. L.³ • Mikulis, D.²

¹University Health Network and University of Toronto, Toronto, ON, CANADA, ²The Toronto Western Hospital, Toronto, ON, CANADA, ³University of Toronto, Toronto, ON, CANADA

PURPOSE

There are two primary methods currently used for assessing blood flow abnormalities in patients with moyamoya disease. These are resting perfusion techniques and vasoactive challenge methods. This study integrates resting perfusion measurements using dynamic contrast-enhanced susceptibility MR imaging with measurements of cerebral vascular reactivity with a CO₂ challenge using BOLD MR imaging to provide a comprehensive characterization of the vascular dysfunction in moyamoya disease.

MATERIALS & METHODS

BOLD MR imaging and dynamic contrast-enhanced susceptibility MR imaging (DSCI) were performed in 5 patients with angiographically confirmed moyamoya disease (4 unilateral, 1 bilateral case) on a 1.5 T clinical MR system (GE Medical Systems, Signa Echospeed). The BOLD sequence was combined with a rebreathing challenge (TR = 2240 ms, TE = 40 ms, FOV = 200 mm, slice thickness = 4.5 mm, no. of slices = 28, matrix 64 x 64 with spiral readout). The CO₂ challenge was applied and acquisition continued for 6 min (8 cycles of high and low pCO₂). Dynamic contrast-enhanced susceptibility imaging was performed using a single-shot GE-EPI sequence (TR = 1750 ms, TE = 30 ms, FOV = 220 mm, slice thickness = 5 mm, no. of slices = 18, matrix = 128*128, temporal resolution = 1.7 s). A bolus of Gd-DTPA (7cc/s) was administered immediately at the start of the dynamic EPI sequence. Data acquisition continued for 25 dynamics. BOLD data was transferred to an independent WS for further analysis. CVR maps were calculated as described previously by Vesely, et al. Parametric maps of relative cerebral blood volume (rCBV) and mean time to enhance (MTE) were calculated on a clinical WS using Functool. Regions of interest were selected in areas of negative reactivity and compared to the homologous ROIs in the contralateral hemisphere. Mean and standard error of the mean (SEM) were recorded and tested for significance using a students t-test.

RESULTS

Parametric perfusion and CVR maps of unilateral disease demonstrate abnormalities (delayed perfusion, negative CVR) compared to the contralateral hemisphere (MTE was delayed in all cases by $9.4\% \pm 3.3\%$, $p < 0.05$; mean CVR in abnormal hemisphere was -0.010 ± 0.019 compared to $+0.039 \pm 0.006$ in contralateral hemisphere with $p < 0.05$). However, perfusion parameter maps became more difficult to threshold in bilateral disease since no reliably normally perfused tissue was present. In contrast, the CVR maps outlined areas of low or negative reactivity for unilateral and bilateral cases which are threshold independent because CVR methodology yields absolute quantitation and is independent of an input function (in contrast to the perfusion

methodology). Cerebral blood volume was not consistently abnormal (in all cases, $p = 0.87$) despite the evidence of significant timing delays and negative reactivity.

CONCLUSION

Our results suggest that CBV measurements are inadequate and that maps showing impaired circulatory delays (e.g., MTE) and evidence of CVR impairment are much more useful in assessing patients with moyamoya disease. Furthermore, CVR permits easy identification of low or negative reactivity - features which identify areas with severe vascular compromise in both unilateral and bilateral disease states. Dynamic contrast-enhanced susceptibility imaging fails to provide reliable results in bilateral cases. In summary, CVR provides unambiguous quantitative determination of diseased tissue, allowing targeted assessment (ROI placement) of local perfusion. Integrating both approaches provides a more comprehensive assessment of vascular integrity.

KEY WORDS: Moyamoya disease, perfusion, cerebral vascular reactivity

Paper 121 Starting at 10:39 AM, Ending at 10:47 AM

Neurovascular Anomalies in Posterior Fossa Malformations, Facial Hemangiomas, Intracranial Arterial, Cardiac, and Eye Syndrome: Findings on Screening MR Imaging and MR Angiography in Five Children

Lowe, L. H.¹ • Church, D. G.^{2,3} • Horii, K. A.¹ • Nopper, A. J.¹

¹Children's Mercy Hospital, Kansas City, MO, ²University of Missouri, Kansas City, MO, ³St. Luke's Hospital, Kansas City, MO

PURPOSE

The purpose of this case series is to present the spectrum of asymptomatic neurovascular and anatomical findings in five children with posterior fossa malformations, facial hemangiomas, intracranial arterial, cardiac, and eye anomalies (PHACE) syndrome emphasizing early detection of these anomalies using screening MR imaging and MR angiography.

MATERIALS & METHODS

A retrospective review of the medical records of 5 children with PHACE syndrome was performed. Data collected included demographics, congenital anomalies of all systems, and neuroimaging findings.

RESULTS

Four of five (80%) children had intracranial arterial anomalies of the circle of Willis (vascular tortuosity and dilatation, focal aneurysms, hypoplasia) on screening MR angiography, and 3 of 5 (60%) had Dandy-Walker malformations on MR imaging. Less frequent anomalies included subglottic hemangioma, absent septum pellucidum, cardiac defects, aortic anomalies, and ophthalmologic anomalies.

CONCLUSION

In children with facial hemangiomas and possible PHACE syndrome, screening MR imaging and MR angiography are useful in the detection of various asymptomatic anomalies of the brain and intracranial arteries. Identification of these anomalies may prove important by identifying children requiring early intervention or close follow-up.

KEY WORDS: PHACE syndrome, MR angiography, neurovascular

Paper 122 Starting at 10:47 AM, Ending at 10:55 AM

Angiographic Appearances of Primary Childhood Central Nervous System Vasculitis and a Comparison with MR Angiography

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PURPOSE

Conventional angiography (CA) is considered to be the gold standard in primary childhood appearances of the central nervous system (cPACNS). Primary appearances of the central nervous system (PACNS) is well described for adults, although no radiographic criteria have been determined so far for cPACNS. The aim of this study was to identify the angiographic features of cPACNS using CA and to compare MR angiography (MRA) against this reference standard.

MATERIALS & METHODS

A retrospective single center cohort study of children (2 months - 18 years old) diagnosed between January 1990 and 31 December 2001 was performed. Neonates and children with secondary vasculitis (Sickle cell disease, moyamoya, migraines, SLE) were excluded. Thirtytwo patients who had presentation MRA and angiography within a month were analyzed. Twenty-seven patients with 64 vasculitic CNS lesions were included. The median age at initial MRA and CA was 7.6 years (0.8-16.5 years).

RESULTS

84.4% (54/64) of cPACNS lesions were stenosis, 12% were occlusions, and 3% were aneurysms. The mean stenosis was 50.4% (Sdev 24.0%). Collateral supply was demonstrated in 4/27 patients. Seventy-six percent had multifocal vessel involvement, 19% had five or more. Unifocal lesions were seen in 23.8%. Unilateral involvement was more common than bilateral disease (90.5% vs 9.5%, $P < 0.05$). The distribution of lesions was proximal in 76% of lesions and distal in 9.5%. When comparing CA and MRA, 45 of 64 CA lesions were correctly identified by MRA (sensitivity 70.3% (95% CI 70.2-70.4%, specificity 97.5% (95% CI 93.6-100%)). The positive and negative predictive values 71.4%, 97.4%. There was no significant difference between MRA and CA for lesion detection ($p = 0.87$). Stenosis of 75-99% was correctly graded in 77.8% of cases with MRA. Stenosis between 50% and 75% had lesser agreement of 48%.

CONCLUSION

This is the largest series of cPACNS and the first to clarify angiographic appearances in this condition. Angiographic findings differ from adult PACNS. Multifocal stenoses are the hallmark of cPACNS and occur predominantly unilaterally within the anterior circulation. The proximal vasculature is affected most with lesser involvement of distal and posterior circulation. Although CA remains the gold standard in cPACNS, there was no significant difference in the ability of MR angiography to detect and characterize lesions compared with angiography ($p = 0.87$). Understanding the limitations of MRA, there is a role for its use in the follow-up of cPACNS patients.

KEY WORDS: Childhood, PACNS, angiography

Paper 123 Starting at 10:55 AM, Ending at 11:03 PM

Pitfalls of Imaging Transcranial Doppler Used Alone in a Sick Cell Anemia Screening Program

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PURPOSE

To report the risk of misinterpreting a normal transcranial Doppler imaging (TCDI) in isolation from cross-sectional imaging and complete clinical history in a screening population of homozygous sickle cell anemia (SCA) patients. Stroke occurs at least in 10% of these children and the risk increases as the cerebral blood flow velocities rise (1). Transfusion greatly reduces the risk of a first stroke in children with SCA who have abnormal results on TCDI (2). Medicaid currently pays for TCDI screening of homozygous SCA and beta thalassemia children based on the STOP trials (1-2). There is no automatic payment for MR imaging-MR angiography (MRI-MRA) and this may lead to a suboptimal outcome.

MATERIALS & METHODS

Retrospective review of homozygous SCA children recruited to the imaging ultrasound screening program of a tertiary referral pediatric hospital (Texas Children's Hospital) was made. Correlation with subsequent MRI-MRA and review of the medical record was performed.

RESULTS

Several children who did not meet the STOP criteria for abnormal TCD underwent subsequent MRI-MRA and were found to have evidence of large vessel vasculopathy with established stroke despite peak mean velocities that were not in the abnormal range (i.e., less than 185 cm/sec) (3).

CONCLUSION

It should be recognized that a sufficient degree of narrowing at the level of the terminal ICA and/or proximal M1 segments can lead to falsely low/normal peak mean velocities in the presence of basal occlusive disease.

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KEY WORDS: Sick cell anemia, transcranial Doppler, MR imaging

Paper 124 Starting at 11:03 AM, Ending at 11:11 AM

Value of 3D Volume Rendering and 2D Multiplanar Reformating in the Postprocessing of Pediatric Neurovascular CT Angiographic Data

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PURPOSE

The purpose of this study was to determine the value of 3D volume rendering and 2D multiplanar reformating vs raw multidetector CT angiographic data in patients with pediatric neurovascular diseases.

MATERIALS & METHODS

Multidetector CT angiography was performed in 60 pediatric patients with a spectrum of neurovascular diseases at two major children's hospitals. The images were sent by digital network to both a PACS workstation (nonprocessed data set) and a Vitrea (Vital Images) workstation. The raw images were postprocessed using 2D gray scale multiplanar reformating (MPR) (oblique, curved oblique, automatic curved oblique) and 3D volume rendering. The postprocessed images were compared to raw nonprocessed CTA data sets (source axial 2D images) with respect to (1) lesion detection; (2) lesion characterization; and (3) important image findings not detectable on the raw images. Statistical analysis was performed using a Fischer-Freeman-Halton test.

RESULTS

Postnatal ages ranged from 10 months to 18 years with the median age, 10 years. Thirty-six of 60 studies were abnormal. Pathologic findings included: AVM ($n = 4$), aneurysm ($n = 3$), miscellaneous vasculopathy ($n = 21$), dissection ($n = 6$), and venous anomalies ($n = 2$). Both the source axial 2D and 3D images detected all lesions. Two-dimensional MPR and 3D processed image data clarified ambiguous findings on source images in 25% of cases. The 3D volume rendered images were superior to the source images in characterizing the spatial relationships of lesion components to normal regional anatomy. Lesion quantitation was superior by 2D curved oblique MPR techniques when performing measurements of tortuous vascular pathology or oblique projecting aneurysms. The 2D MPR curve oblique reformatted images were superior to the source 2D images in the quantitative analysis of cervical dissection and in the visualization of inti-

mal flaps and intramural hematoma. In a subset of patients with serial examination, 2D MPR techniques allowed for consistent reproducible accurate measurements of luminal stenosis over multiple time points.

CONCLUSION

Three-dimensional volume rendering and 2D MPR of multi-detector 3D CT angiography are useful adjunctive tools in the characterization of pediatric neurovascular helical CTA source image data when compared to source data alone. Lesion quantitation is superior by 2D MPR techniques when dealing with eccentric luminal stenosis, nonorthogonal measurements, and tortuous vascular pathology. Two-dimensional MPR also provided accurate reproducible measurements of luminal stenosis in the analysis of serial data.

KEY WORDS: CT angiography, multiplanar reformatting, volume rendering

Paper 125 Starting at 11:11 AM, Ending at 11:19 AM

Functional MR Imaging Study of Emotional Stroop Performance in Adolescents with Disruptive Behavior Disorder

Wang, Y. • Mathews, V. • Kronenberger, W. • Li, T. • Dunn, D. • Kalnin, A. • Mosier, K.

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PURPOSE

While performing a modified Stroop task using emotional words, aggressive disruptive behavior disorders (DBD) patients and matched healthy subjects were studied using functional MR imaging (fMRI) to evaluate brain activation elicited by emotional stimuli.

MATERIALS & METHODS

All subjects were screened with DSM IV criteria. Fourteen subjects fulfilled the diagnostic criteria for DBD with at least one of seven aggression criteria. A control group of 14 subjects with no psychiatric diagnosis, matched on age, gender, and IQ with the DBD subjects, also was recruited. All subjects and their parents rated the subjects' violent media exposure (VME) in the past. The paradigm consisted of 9 alternating control (5) and activation (4) 30-second blocks. Each subject was requested to press different buttons according to the ink color of the visually presented word after silently pronouncing the word. During the activation period, words describing violent actions (e.g. hit, harm) were presented, while nonviolent action words (e.g., run) were shown for control phase. All words were selected by an experienced psychologist, so that violent and nonviolent words were balanced for general use frequency in the English language. Functional MR imaging data were acquired as follows: 3D dual echo spiral sequence with TR/TE/TE2 = 3000//35/70 ms; 32 3.8 mm contiguous axial slices for 100 repetitions (5 minutes). Functional scan data were motion corrected using AFNI. Cross correlation of single voxel MR imaging time series was performed using a gamma variate reference function after removal of linear baseline drifts to create individual activation maps of percentage signal change of activation phase vs control phase. All single subject maps were transformed into Talairach space and merged to different group maps (control and DBD x high and low VME).

RESULTS

Behavioral performance data showed that the emotional Stroop task reliably produced interference effects on response latency and accuracy across subjects. However, statistically significant differences were found only between DBD subjects with high and low MVE ($p < 0.05$). Functional MR imaging group maps showed significant signal changes ($p < 0.01$) in the anterior cingulate cortex (ACC), orbitofrontal cortex (OFC), left dorsolateral prefrontal cortex (DLPFC) in the DBD group, while activation was mainly observed in left DLPFC and amygdala in the control group. In both DBD and control groups, subjects with high MVE demonstrated more activation in OFC than subjects with low MVE.

CONCLUSION

This study using the Stroop paradigm with emotional content extends our previous findings by demonstrating different fMRI activations by DBD and control groups with low or high MVE. Differences in signal changes between the DBD and control group, as well as between groups with high and low MVE, may suggest a greater tendency to activate brain regions associated with self-control and executive functioning when individuals with DBD and/or high MVE are presented with emotional stimuli. This may reflect greater reactivity to emotional stimuli than is seen in controls and in individuals with low MVE.

KEY WORDS: fMRI, disruptive behavior disorders

Paper 126 Starting at 11:19 AM, Ending at 11:27 AM

BOLD Contrast Functional MR Imaging in Presurgical Mapping of the Brain Cortex of Pediatric Patients with Brain Space Occupying Lesions

Cauro, M. • Ferretti, A. • Cifaratti, A. • Gorgoglione, A. • Tartaro, A. • Colosimo, C.

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Chieti, ITALY

PURPOSE

BOLD contrast functional MR imaging (fMRI) has become a well consolidated noninvasive procedure for presurgical mapping of cortical functions in adult patients. We adopted the paradigms used for adults to the cognitive level of pediatric patients and studied compliance in a group of children in whom cortical mapping was required for surgery.

MATERIALS & METHODS

Eleven young patients (7 females, 4 males; age range 9-16 years) with brain lesions were studied. Consciousness and sensory-motor functions were within normal limits in all but one patient. Functional MR imaging was performed according to a block paradigm alternating rest/control to task conditions. Motor functions were explored using the "finger tapping" task for the hand, toe flexion for the foot, and lip contraction for the facial area. Hemispheric dominance for language was assessed using two tasks: (1) object-naming (patients were required to silently name objects represented in pictures projected on the screen) and (2) word generation. This latter task was obtained by asking the patients to generate words beginning with a given letter; the letter was projected together with a drawing of a cargo-ship which, metaphorically, is carrying a large amounts of words. A

training session of approximately 1 hour was conducted immediately before the fMRI. Functional MR imaging acquisitions were performed with a 1.5 T MR unit using BOLD technique with echo-planar imaging. Functional MR imaging data were analyzed with Brain Voyager 4.9 software.

RESULTS

Complete cooperation of all but one patient was obtained. The finger-tapping task yielded good somatotopical congruence except in a patient with cortical dysplasia of the left motor cortex: in this patient right finger tapping activated a region that was located more laterally and ventrally than expected. Lips contraction bilaterally activated the base of the precentral gyrus. The word generation task activated the inferior frontal gyrus and posterior superior temporal region with either a strong left (7 patients) or right (4 patients) lateralization (Figure 1). Seven patients were operated: vascular malformation (3), tumors (5), and cortical dysplasia (2). Patients have to date undergone multiple follow-up visits and none reported any new neurologic deficit after surgery. Fig. 1 Right parietal ganglioglioma in an 11-year-old boy. Activation during the "word generation" task in the left hemisphere (Broca's and Wernicke's areas). Activation in the left precentral gyrus which most likely represents the vocalization center.



CONCLUSION

Functional MR imaging is a feasible technique for presurgical mapping of the cerebral cortex in pediatric patients with brain lesions. The use of very simple and not time-consuming tasks makes fMRI possible in young patients after an adequate training. Brain mapping allowed surgical saving of functionally eloquent regions of the cortex and ensured a good clinical outcome.

KEY WORDS: Brain tumor, fMRI, pediatric

Paper 127 Starting at 11:27 AM, Ending at 11:35 AM

Proton MR Spectroscopic Imaging in Differential Diagnosis of Pediatric Brain Lesions

Hourani, R. • Albayram, S. • Okoh, J. • Melhem, E. R. • Cohen, K. • Weingart, J. • Carson, B. • Burger, P. • Barker, P. B.

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PURPOSE

Noninvasive diagnosis of brain lesions prior to surgery may assist the treatment and reduce risks to patients. Our aim was to investigate whether proton MR spectroscopic imaging (MRSI) can aid in differentiating between brain tumors and nononcologic pediatric lesions.

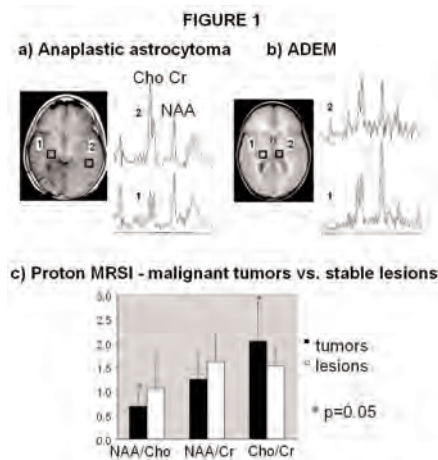
MATERIALS & METHODS

We retrospectively examined 31 children with primary brain lesions (age = 10 ± 5 years, 20 boys). Twenty patients had a brain tumor, neuropathologically confirmed (high-grade gliomas ($n = 8$), low-grade glioma ($n = 6$), medulloblastoma, choroid plexus carcinoma, ganglioglioma, xanthoma, leptomeningeal gliomatosis, germinoma (one each)). Eleven patients had a benign stable lesion (acute demyelinating encephalomyelitis (ADEM, $n = 4$), mesial temporal sclerosis, postsurgical gliosis, hamartoma, edema associated with hematoma (one each), nonpathologically confirmed lesions ($n = 3$)) and have been followed up for 2 years with no evidence of lesion progression and clinical deterioration. MR imaging and multislice MRSI (1) were performed at 1.5 T before any treatment. Three or four oblique axial slices were measured with slice thickness/gap = 15 mm/2.5 mm, TR/TE = 1700 (or 2300)/280 ms. In the spectra, which were evaluated in the lesion and in the contralateral normal appearing parenchyma, signals of N-acetyl aspartate (NAA), creatine (Cr) and choline (Cho) were detected. Ratios NAA/Cho, NAA/Cr, and Cho/Cr were evaluated from areas under the respective signals.

To compare metabolite ratios in lesions and normal tissue, the Wilcoxon paired signed rank test was applied. Statistical significance was set to $p < 0.05$. Data are presented as means $\pm$ standard deviations.

RESULTS

Figure 1 shows examples of spectra in a tumor (1a) and a nononcologic lesion (1b). Compared to normal appearing tissue, average ratios NAA/Cho (0.67 ± 0.32) and NAA/Cr (1.24 ± 0.56) were lower by 60% and 41%, respectively, and average Cho/Cr (2.02 ± 0.83) was higher by 55% in malignant tumors ($p = 0.0001$, 0.0003 and 0.002 , respectively). In stable lesions, NAA/Cho (1.05 ± 0.49) was lower by 44% and Cho/Cr (1.51 ± 0.4) higher by 24% ($p = 0.003$ and 0.05 , respectively) than in control regions. No significant difference in NAA/Cr between nononcologic lesions and control tissue was identified. Average ratio NAA/Cho was by 36% lower and average Cho/Cr was by 34% higher in malignant tumors than in stable lesions (Figure 1c, both $p = 0.05$). No significant difference in ratio NAA/Cr between malignant tumors and nononcologic lesions was detected.



CONCLUSION

Our study demonstrates a promising role of proton MRSI for distinguishing brain tumors from nononcologic lesions. Higher ratio Cho/Cr and lower ratio NAA/Cho presumably reflects higher Cho levels in tumors, in agreement with previously published data (2-5). Proton MRSI may therefore have a valuable diagnostic importance, particularly in inoperable or inaccessible lesions.

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KEY WORDS: Pediatric brain tumors, proton MR spectroscopic imaging, choline

Paper 128 Starting at 11:35 AM, Ending at 11:43 AM

MR Spectroscopy of Pediatric Brain Lesions with Indeterminate Conventional MR Imaging

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¹Emory University School of Medicine, Atlanta, GA,

²Children's Healthcare of Atlanta at Scottish Rite, Atlanta, GA

PURPOSE

Primary brain neoplastic and nonneoplastic mass lesions in pediatric patients often have similar nonspecific MR imaging characteristics. We present a retrospective review of 22 patients with primary cerebral mass lesions evaluated by conventional MR imaging that demonstrate MR spectroscopy (MRS) patterns distinct from those observed with low- or high-grade brain tumors.

MATERIALS & METHODS

Twenty-two children with primary brain lesions demonstrating stability on follow-up imaging or with a pathologically proven diagnosis of benign histology were reviewed. All children had both conventional MR imaging and proton MRS. Short and long TE MRS was performed and compared with spectra from pathologically proven low-grade and high-grade brain tumors with a similar conventional MR appearance.

RESULTS

Patients with benign histology or stable follow-up MR findings had a distinct MRS pattern. The pattern observed was characterized by mild decrease in NAA, normal creatine, no remarkable elevation of choline, and normal to slightly increased myoinositol.

CONCLUSION

MR spectroscopy can help differentiate nonneoplastic mass lesions from brain neoplasms that demonstrate nonspecific conventional MR appearance. This is particularly effective in pediatric populations which have a relatively high percentage of such lesions. MR spectroscopy can provide tissue specificity greater than MR imaging. MR spectroscopy potentially can influence clinical management and could obviate the need for future biopsy.

KEY WORDS: MR spectroscopy, pediatric brain lesions, low-grade brain neoplasm

Paper 128A Starting at 11:43 AM, Ending at 11:51 AM

Neuroimaging In 479 Term Infants Diagnosed With Hypoxic Ischemic Encephalopathy (HIE).

Poskitt, K. J. • Hill, A. • Roland, E. • Sargent, M. A.

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Vancouver, BC, CANADA

PURPOSE

To review the changing patterns of injury identified by neuroimaging in term infants who suffered HIE.

MATERIALS & METHODS

Since 1985 neonates clinically suspected to have suffered from HIE and imaged in the first week of life have been entered into a database. Four hundred seventy-nine term infants underwent CT imaging at 72 hours according to our protocol(1). Follow up ranged from 18 months to 15 years. Since 1994, 79 (36%) patients were imaged with MR. Imaging reports were filed with the request form and between 2002-2003, all studies were reviewed by two observers for the degree and location of involved cortex, white matter, thalami and basal ganglia, brainstem, and cerebellum. 30% of cases were double read.

RESULTS

The 2002 classification agreed with the reports in 97% of cases. Imaging was normal in 234, and increased from 33% before 1994 to 54% after. As reported (1), CT findings were predictive of neurologic outcome with 85% positive predictive value (PPV) and 83% NPV. Seventy-nine MRIs were obtained; 17 (22%) between days 1-4, 25 (32%) days 5-9, 30 (38%) days 10-14 and only 6 between days 15-21. 31% of MRIs were obtained in patients with acute profound asphyxia, 15% in severe prolonged partial, 33% in CT normal and 16% in equivocal studies. Since 1994, 49% of all patients with acute profound asphyxia have had MRIs. 20% of patients with severe prolonged partial asphyxia identified by CT have been imaged. CT and MR agreed in 69/79 (87%) of cases. CT missed 2 thalamic injuries seen on MR in patients who developed choreoathetoid CP, while CT correctly recognized 4 cases missed by MR imaging at 10 days of life. Selective white matter injury was missed twice on MR and two discordant cases were due to inadequate imaging. There

was no difference in the ability of CT or MR to predict neurological outcome. Imaging patterns of cerebral injury changed markedly over time. Acute profound asphyxia represented only 16% of abnormal cases before 1994 but 54% of cases after 1994. The imaging frequency of pure prolonged partial injury and combined patterns of injury dropped by 50% since 1994. Fifty percent of all cases of pure prolonged partial injury or combined patterns of injury had been collected by 1991 compared to 1996 for acute profound asphyxia.

CONCLUSION

We have accumulated a database of infants believed to have suffered from HIE who underwent neuroimaging and have long-term clinical follow up. Based on 479 CTs and 79 MRs there has been no significant difference in the ability of day 3 CT and early MR studies to identify patterns of injury and predict neurological outcome. There has been a significant change in the patterns and severity of neonatal injury over the past 16 years.

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KEY WORDS: hypoxic ischemic encephalopathy

Paper 129 Starting at 11:51 AM, Ending at 11:56 AM

Combined Positron Emission Tomography/CT Imaging of Pediatric Head and Neck Oncologic Disease

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PURPOSE

Recently, combined CT/PET imaging has been introduced and recent studies have proven that combined CT/PET imaging may improve the diagnostic accuracy of staging of adult head and neck oncologic disease. However, the use of combined CT/PET imaging has not been studied specifically with respect to pediatric head and neck oncologic disease. The purpose of the study was to evaluate the added value of using combined PET/CT imaging compared to PET imaging alone in the characterization of PET lesions in pediatric head and neck oncology.

MATERIALS & METHODS

A total of 15 consecutive head and neck PET/CT examinations were performed in a total of 10 pediatric patients. Following the iv injection of 18-fluoro-2-deoxyglucose (FDG) and a standard uptake period, each patient was imaged on a CT whole body PET/CT (CTI Reveal) scanner. After a whole body CT image was acquired for photon attenuation correction, multiple 3-minute bed position acquisitions were obtained along the length of the patient's body from the mid thighs to the base of the skull. Lesions were initially identified and characterized on PET alone. The lesions then were compared in a retrospective manner between the PET alone and the combined PET/CT images. Tumor staging was confirmed histologically in a subset of patients.

RESULTS

The diagnoses included papillary thyroid carcinoma (n = 3), Hodgkin's disease (n = 6), non-Hodgkin's disease (n = 1). Specific examples of added value of the combined PET/CT images which will be demonstrated included: (1) better anatomical localization and differentiation of hypermetabolic foci in the head and neck region which correlated with normal anatomical structures demonstrating brown fat or normal physiologic function; (2) better anatomical localization of tumor recurrence; (3) better anatomical localization of hypermetabolic foci in Hodgkin's disease lymph nodes not considered significant due to CT size criteria.

CONCLUSION

This study suggests that combined PET/CT imaging provides added value regarding PET lesion characterization in a subset of pediatric head and neck oncologic cases when compared to PET alone.

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KEY WORDS: CT/PET imaging, lymphoma, brown fat

Tuesday Morning

10:15 AM - 11:50 AM

Room 611 - 612

**(23d) Pediatrics: General and
Leukoencephalopathy
(Scientific Papers 130 - 142)**

See also Parallel Sessions

(23a) Adult Brain: Epilepsy

(23b) Head & Neck: General

*(23c) Pediatrics: General, Functional, and Vascular
Imaging*

Moderators: P. Ellen Grant, MD
Susan Palasis, MD

Paper 130 Starting at 10:15 AM, Ending at 10:23 AM

Apparent Diffusion Coefficient and Cerebrospinal Fluid Flow Measurements in Patients with Hydrocephaly

Demirci, A. • Anik, Y. • Arslan, A. • Anik, I. • Etus, V.

Kocaeli University School of Medicine
Kocaeli, TURKEY

PURPOSE

To evaluate and correlate diffusion MR and CSF flow imaging in hydrocephaly before and after treatment.

MATERIALS & METHODS

Eighteen patients (12 female, 6 male), 11 of which were in the pediatric age group were included in the study. Of the pediatric age group 9 were under 1 year old. The pediatric age group consisted of 8 primary aqueductal stenosis, 2 Dandy-Walker malformation with aqueductal stenosis and 1 hydrocephaly following operation for myelochisis. In the adult patient group 6 had normal pressure hydrocephaly and 1 had pineal gland tumor with mass effect on aqueductus sylvii. As control group 21 healthy age-matched patients were examined. Cerebrospinal fluid flows measurements were obtained in the aqueduct in all patients and in the prepontine cistern in 16 patients with third ventriculostomy. The changes in ADC values from 8 ROIs were evaluated. The change in frontooccipital ratio (FOR) was calculated and periventricular hyperintensity was assessed before and after treatment. Cerebrospinal fluid flow parameters, FOR, and periventricular hyperintensity were correlated with ADC values. Additionally ADC values of the study group before and after treatment were compared with that of the control group.

RESULTS

Apparent diffusion coefficient values were significantly higher in the preoperative period than the postoperative period ($p < 0.05$). The preoperative ADC values were significantly higher than that of the age-matched control group ($p < 0.05$). The postoperative ADC values were similar to the control group values. The decrease in ADC values showed linear correlation with CSF flow measurements. There were significant correlations among the changes of FOR, ADC values, and CSF flow parameters.

CONCLUSION

Apparent diffusion coefficient measurement is found to be useful in the evaluation of treatment and follow-up of patients with hydrocephaly.

KEY WORDS: Diffusion MR, hydrocephaly, CSF flow

Paper 131 Starting at 10:23 AM, Ending at 10:31 AM

Leukoencephalopathy with Vanishing White Matter in Four Brazilian Patients

Brenner, C.¹ • Martins, C. E. S.¹ • Brum, J. M.¹ • Pronk, J. C.² • van der Knaap, M. S.²

¹The SARAH Network of Hospitals for the Locomotor System, Brasília, BRAZIL, ²Free University Medical Center, Amsterdam, NETHERLANDS

PURPOSE

To report the clinical and imaging findings of four patients with leukoencephalopathy with vanishing white matter (VWM), recently defined as an autosomal recessive disorder (OMIM 603896).

MATERIALS & METHODS

The patients, presenting with ataxia and delayed cognitive development, underwent neurophysiologic studies, metabolic investigation, and conventional MR imaging. One patient had MR spectroscopy (MRS) and diffusion-weighted imaging performed. Two patients were submitted to molecular studies.

RESULTS

All patients developed ataxia during childhood. Cognitive deficit was recorded. The course of the disease was chronic-progressive. Two patients had additional episodes of more rapid deterioration, provoked by head trauma and infection. Two female patients were siblings and had primary amenorrhea due to ovarian failure (1). No parents were consanguineous. Neurophysiologic studies were progressively abnormal, according to the stage of the disease. No inborn errors of metabolism were detected. Two patients underwent molecular studies: one of the sisters was compound heterozygous for two mutation in the EIF2B2 gene (599G > T and 638A > G), both leading to an amino acid substitution in the protein. The other patient was homozygous for 338G > A in the EIF2B5 gene, again leading to an amino acid substitution. MR features were stage-dependent. Extensive cerebral white matter changes were found on T2-weighted images. On fluid attenuated inversion recovery (FLAIR) images, the cerebral white matter was atrophic and almost completely hypointense on both sides of the brain in the oldest patient, and less hypointense in the youngest ones. Corpus callosum was affected in all patients. Cerebellar atrophy was universal. Pontine central tegmental tracts had a hyperintense signal on

T2-weighted imaging; another patient had hyperintense pyramidal tracts. A cavum septum pellucidum was present in one patient. MR spectroscopy showed decrease in all metabolites in the affected areas and increased lactate peak. Lactate also was present in the subcortical areas (2), where diffusion-weighted imaging displayed restricted diffusion.

CONCLUSION

The imaging findings by MR imaging and MR spectroscopy are characteristic and allow diagnosis. We emphasize the association of leukoencephalopathy with VWM and ovarian failure, which should raise suspicion of this entity.

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KEY WORDS: Leukoencephalopathy, diagnosis, genetics

Paper 132 Starting at 10:31 AM, Ending at 10:39 AM

Vacuoliting Megalencephalic Leukoencephalopathy with Subcortical Cysts in Seven Brazilian Patients

Brenner, C.¹ • Martins, C. E. S.¹ • Brum, J. M.¹ • Nakayama, M.² • Mello, W. D.³ • Sousa, M. B. O.³ • Pronk, J. C.⁴ • van der Knaap, M. S.⁴

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PURPOSE

To report the clinical and imaging findings of seven patients with vacuoliting megalencephalic leukoencephalopathy with subcortical cysts (OMIM 604004).

MATERIALS & METHODS

The patients, presenting macrocephaly and delayed motor development, were submitted to neurophysiologic studies, metabolic investigation, and MR imaging. In four patients molecular studies were performed.

RESULTS

All patients slowly developed ataxia and spasticity. Language development was very poor. Four had epilepsy controlled with medication. Neurophysiologic studies results were variable. No inborn errors of metabolism were detected. Two patients were relatives, uncle and niece, belonging to a highly consanguineous family. They were homozygous for the del594-597 mutation in the gene MLC1, leading to a stop codon and a truncated protein. Another patient was homozygous for the 597delAIVS33bp mutation in MLC1, also leading to a stop codon and truncated protein. The fourth patient presented no mutation in the gene. MR features were megalencephaly with swelling of the abnormal hemispheric white matter, subcortical cysts in the frontoparietal area and/or temporal lobes tips and persistence of a

cavum of septi pellucidi and vergae. Central white matter structures were relatively spared. Gray matter was preserved. One patient had an incidental pituitary macroadenoma.

CONCLUSION

Vacuoliting megalencephalic leukoencephalopathy with subcortical cysts was first described in 1995 by van der Knaap, et al. (1). Autosomal recessive mode of inheritance was suggested. European countries, Japan, Turkey, and India have reported this entity. Only two cases have been reported in Brazil (2). We report seven new Brazilian patients.

REFERENCES

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KEY WORDS: Leukoencephalopathy, diagnosis, genetics

Paper 133 Starting at 10:39 AM, Ending at 10:47 AM

MR Imaging of the Brain in Patients with Isolated Sulfite Oxidase Deficiency

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PURPOSE

Sulfite oxidase deficiency is a rare devastating infantile neurometabolic disease. Both the isolated form and the more frequent molybdenum cofactor deficiency show similar presentation: intractable infantile seizures, hypotonia replaced by spasticity, feeding difficulties, and profound developmental delay. We present 3 cases of isolated sulfite oxidase deficiency. Two of them are siblings.

MATERIALS & METHODS

Three patients (2 of them siblings) with isolated sulfite oxidase deficiency (SOD) presented in the neonatal period with lethargy, intractable seizures, dysmorphism, and mixed tone. Metabolic workup was positive for urine sulfite, normal blood uric acid, and low cysteine. Two patients underwent MR study at the 1st month of life and the 3rd patient at the age of 5 months. The MR study included T1- and T2-weighted images and MR spectroscopy.

RESULTS

The early MR studies showed marked T2 and T1 prolongation at the central and the subcortical white matter. The basal ganglia and thalami were small with short T1 values containing small foci of long T1 and T2 signal. The late MR study at the age of 5 months was performed on the sibling of the 1st patients and showed marked atrophy of both gray and white matter, with no progress of myelination. The CSF spaces, including the ventricles, were enlarged. The MR spectroscopy in all patients demonstrated a very low NAA/Cr ratio with high ratio of Cho/Cr and high lactate peaks.

CONCLUSION

We present 3 cases of SOD with typical MR and MR spectroscopy findings with good correlation with the severity of the clinical condition.

KEY WORDS: Sulfite oxidase deficiency, MR imaging

Paper 134 Starting at 10:47 AM, Ending at 10:55 AM

Hemimegalencephaly: MR Imaging in Twelve Children with Pathologic Correlations

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PURPOSE

Hemimegalencephaly is a rare malformation causing intractable seizures in early infancy with unilateral hypertrophy of the brain. MR imaging is useful to identify the extent of the disease. The reported anomaly includes abnormal gyral pattern and thickened cortex, over or under development of the white matter, and dysmorphic basal ganglia. Twelve cases of hemimegalencephaly were reviewed retrospectively and MR images were compared to the pathologic specimens.

MATERIALS & METHODS

The twelve patients including six males and six females were studied retrospectively. The patient's age is from 1.5 month to 42 months at the time of imaging (mean 7 months). All patients were presented with severe seizures at birth and underwent hemispherectomy within 2 months after the MR exam. MR study was performed using 1.5 T Signa with T1 sagittal, T2 coronal, T2 axial, and SPGR coronal or axial images. Pathology specimen was evaluated postsurgically and compared to the MR findings. Images were assessed for extent of gray matter anomaly, white matter signal abnormality, basal ganglia involvement, hippocampal involvement, and cerebellar anomaly.

RESULTS

Imaging studies: All patients had multilobar gyral anomaly. The right hemisphere was involved in five patients and left hemisphere in seven patients. White matter signal abnormality was noted in all 12 patients. Basal ganglia signal abnormality was seen in seven patients. The basal ganglia were ill defined in five patients. Asymmetry of the olfactory tract was seen in five cases. Two of them showed tongue-like hypertrophy of the olfactory tract. Hippocampus was smaller in four cases and showed vertical orientation in three cases. No cerebellar anomaly was noted. Pathology: All patients showed loss of lamination of the gray matter and cytomegalic neurons in the affected gyri. Three patients showed significant micro calcifications in the white matter. MR signal of the white matter was heterogeneous in these cases. One patient showed severe dysmorphic glioneuronal hamartomas in the basal ganglia. Scattered heterotopias often are seen in the subcortical white matter. This is often difficult to appreciate in MR imaging. Hippocampus is poorly developed in four cases with no formation of normal gray matter.

CONCLUSION

MR imaging identified the extension of anomaly of the gray and white matter. T2-weighted sequence was useful to evaluate extension of the gray matter abnormality in infants. Variety of degree of white matter and basal ganglia abnormality was seen in hemimegalencephaly. The hippocampus was also abnormal. The extent of the anomaly may help surgical planning.

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KEY WORDS: Pediatric brain, epilepsy, hemimegalencephaly

Paper 135 Starting at 10:55 AM, Ending at 11:03 AM

Longitudinal MR Imaging Changes and MR Spectroscopy of Neurocutaneous Melanosis with Subsequent Development of Malignant Peritonitis

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PURPOSE

To demonstrate longitudinal MR imaging changes of neurocutaneous melanosis. To describe baseline MR spectroscopy (MRS) in areas with positive findings of melanosis, as a method of following the progression of the disease. To describe nonmalignant and malignant sequela of neurocutaneous melanosis, such as syrinx formation, hydrocephalus, arachnoiditis, diffuse meningeal melanosis and malignant transformation within, vs seeding of, the peritoneum after placement of a ventriculo-peritoneal shunt.

MATERIALS & METHODS

Brain imaging studies were obtained at birth, including sagittal, axial, and coronal T1-weighted images, pre and postgadolinium administration, axial and coronal T2-weighted images, axial T2 FLAIR and T2 gradient-echo images. Spine images included sagittal pre and postgadolinium T1-weighted, T2-weighted, and T2 short tau inversion recovery (STIR) images. Follow-up examinations were obtained at 2 month, 4 month, and 13 month intervals for the brain. Baseline single voxel STEAM MRS with short (30 msec) and long echo times (270 msec) was performed 4 months after the initial study, for baseline assessment (no malignancy was evident at this time). Sagittal and axial, pre and post-contrast T1-weighted, axial T2 gradient echo, coronal T2-weighted, and axial T2 FLAIR images also were obtained at this time. Follow-up spine studies were obtained 7 and 8 months after the initial study.

RESULTS

On initial studies, symmetric increased T1 signal was observed in the amygdala, on the surface of the pons, within the bilateral superior colliculus and on the surface of the cerebellar folia. Ventriculomegaly was present at birth and increased slightly over the next few weeks. A ventriculoperi-

toneal shunt was placed at approximately 3 months of age (DOB 11/5/01 and shunt was placed after 1/23/02). At the age of 7 months, the patient developed a cervical syrinx and arachnoiditis. At 7 months after the initial study, dural-based plaque-like contrast enhancement was seen along the tentorium and along surface of the spinal cord in the thoracic and lumbar regions. A baseline abdomen-pelvis CT scan was obtained at the age of 10 months demonstrating peritoneal carcinomatosis (7 months after ventriculoperitoneal shunt placement). MR spectroscopy demonstrated no evidence of lactate on the baseline study in the areas of imaging abnormality. The NAA:Choline ratio was decreased, but this was attributed to volume averaging with cerebral spinal fluid in adjacent areas.

CONCLUSION

Neurocutaneous melanosis is a rare and potentially malignant condition that begins early in fetal development. Melanosis of the brain and meninges is seen most commonly as abnormal bright signal on T1-weighted imaging in the region of the amygdala and cerebellum. These imaging findings may evolve with time and become obscure after myelination. Some of the complications of neurocutaneous melanosis are hydrocephalus, syrinx development, meningeal, spinal cord, and root melanosis with malignant transformation within the CNS. Malignant transformation of viscera typically does not occur. Peritoneal malignant transformation occurred in our case, either spontaneously or by spread via a ventriculo-peritoneal shunt. Baseline MRS in sites of initial melanosis was normal.

KEY WORDS: Neurocutaneous melanosis, malignant degeneration, syrinx

Paper 136 Starting at 11:03 AM, Ending at 11:11 AM

Limited Value of Gadolinium Administration for Brain MR Examinations in the Context of Seizure Evaluation in Children under Two Years of Age

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PURPOSE

To assess the added contribution of gadolinium to the MR work-up of seizures in children under 2 years of age and review radiologic findings and associated clinical symptoms in this group.

MATERIALS & METHODS

Over a 7.5 year period (1995-2002), 507 gadolinium-enhanced MR examinations of the brain were performed in children under the age of 2 years presenting with seizures either as the primary/only clinical problem or as an integral part of a more complex clinical scenario. We retrospectively reviewed the medical records, stated indications, and MR findings on all of these patients.

RESULTS

Of the 507 examinations reviewed, 246 (49%) did not reveal any significant abnormality. Most abnormalities encountered were identified easily and characterized without utilization of gadolinium. Pathologic contrast enhancement or lack

thereof was felt to contribute significantly to the diagnosis in 44 cases. Out of these 44, only in 14 cases (i.e., 2% of the total number of examinations performed) would the findings have been missed on the noncontrast images. Ten of these cases proved to be meningitis which was strongly suspected clinically, with fever and/or lactic acidosis being present in all ten cases. One case was related to tumor recurrence post-surgery and in one case contrast was helpful in formulating the diagnosis of astrocytoma in a child with tuberous sclerosis. The other two cases were diagnosed as developmental venous anomalies of doubtful clinical significance. No clinically relevant findings were missed on the noncontrast images in cases where seizures were the only presenting symptom.

CONCLUSION

Gadolinium administration in MR examinations performed for the work-up of seizures in children under the age of 2 years added important diagnostic information in a very limited number of cases, especially when seizures were not accompanied by other clinical findings. We would suggest that contrast be reserved only for cases with additional signs and symptoms pointing to infection or neoplasia.

KEY WORDS: Seizures, brain MR imaging, gadolinium

Paper 137 Starting at 11:11 AM, Ending at 11:19 AM

Reversible MR Signal Changes in the Splenium of the Corpus Callosum in Infectious Encephalopathy

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PURPOSE

To investigate the transient MR signal changes seen in the splenium of the corpus callosum in six patients with viral or bacterial encephalopathy.

MATERIALS & METHODS

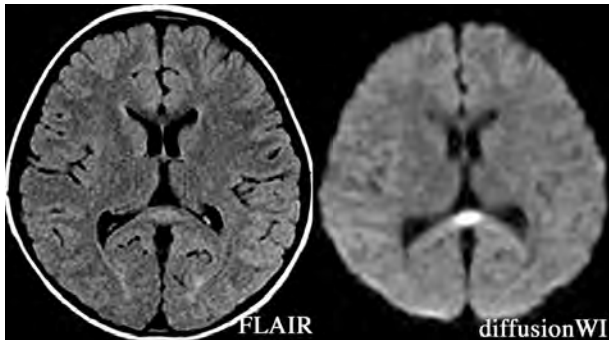
Six patients with infectious encephalopathy were examined on serial brain MR imaging with 1.5 T magnet (GE, signa). The patient's age, sex, main symptoms on admission to our hospital and revealed pathogen are summarized in Table 1. All patients underwent the initial MR imaging within 3 days after the onset of symptoms.

RESULTS

The hyperintensity lesion in the splenium of the corpus callosum was shown in all patients, which was more conspicuous on diffusion-weighted images than T2-weighted and FLAIR images (Figure 1). Follow-up MR images obtained from 4 to 10 days after the prior MR imaging, revealed the hyperintensity abnormalities resolved in all patients except patient 6, whose MR images showed not only the lesion in the corpus callosum but diffuse spread of high intensity abnormalities in the frontal and the occipital cortex bilaterally. The patient subsequently expired on 26 days after the onset of infection. The other patients recovered completely with no abnormal findings on follow-up MR images. The reason for the predilection for the splenium of the corpus callosum is not clear. We speculate that the splenium of the corpus callosum is around a boundary zone of anterior cerebral artery and posterior cerebral artery and easy to suffer cellu-

lar energetic failure from pathogenic endotoxin directly or its immune reactions indirectly. Our findings do not exclude an element of vasogenic edema but strongly suggest that cytotoxic edema was the major operant factor in the pathogenesis of infectious encephalopathy in our patients. ADC values of the splenium of the corpus callosum in patients 1, 2, and 3 were markedly decreased compared to those in normal areas. Follow-up diffusion-weighted MR images of these patients showed a reversal of the ADC drop. This change is interesting because if these lesions were areas of infarctions, decreased ADC would imply irreversibility of the lesions. Based on our cases and the reported cases with epilepsy, cytotoxic edema caused by mechanisms other than arterial ischemia does not necessarily suggest irreversibility of the lesions.

Patient No.	Age(y)/Sex	Patients Data	
		Main Symptom	Revealed Pathogen
1	8 / female	fever diarrhea disorientation	Salmonella Enteritidis
2	2/female	fever convulsion	Rotavirus
3	9/female	fever convulsion disorientation	Influenza A
4	5/male	fever convulsion disorientation	Influenza A
5	5/male	fever disorientation	Adenovirus
6	4/male	fever convulsion disorientation	Influenza A



CONCLUSION

Diffusion-weighted MR imaging is a potentially useful method for detecting early changes of infectious encephalopathy, although the exact mechanism of the restricted diffusion remains to be clarified.

KEY WORDS: Brain MR, corpus callosum, viral infection

Paper 138 Starting at 11:19 AM, Ending at 11:27 AM

Imaging Characteristics of Giant Juvenile Xanthogranuloma

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PURPOSE

Juvenile xanthogranuloma (JXG) is a benign, non-Langerhans cell histiocytic proliferation most often occurring in the skin of children. The term "giant JXG" is used for lesions larger than 2 cm in diameter, which are usually characterized by initial rapid growth followed by a benign course and gradual involution. Juvenile xanthogranuloma may occur occasionally in extracutaneous sites, such as the calvarium and muscle tissue, but as radiologists are not familiar with this entity, the correct diagnosis is rarely anticipated preoperatively. We evaluated the imaging features of three cases of giant JXG occurring along the neuraxis and compared them with other cases reported in the literature.

MATERIALS & METHODS

The medical records and imaging studies of three patients with the diagnosis of giant JXG were evaluated in a retrospective manner. One patient was imaged with CT and all three patients were imaged with MR imaging. Contrast-enhanced T1-weighted images also were obtained in all MR cases. Surgical resection with histologic examination was performed in all children.

RESULTS

Three patients (2 girls, 1 boy), aged between 5 fi months and 12 years, were evaluated. One patient had a right subperiosteal parietal bone mass that was imaged with CT, which revealed saucerization of the outer table of the calvarium, and mottled lytic destruction of bone. A stalk of tumor extending to dura was not appreciated preoperatively. The second patient had an intracranial, extraaxial mass abutting the left anterior parietal lobe. The third patient had a right paraspinal tumor. All tumors appeared similar on MR imaging: sharply circumscribed and homogeneous, slightly hyperintense relative to muscle on nonenhanced T1-weighted images and isointense or hypointense relative to gray matter on T2-weighted or FSEIR images. Following the administration of contrast, moderately intense, homogeneous enhancement occurred. Histologic examination in all cases showed aggregates of xanthomatous mononuclear cells characteristic of juvenile xanthogranuloma.

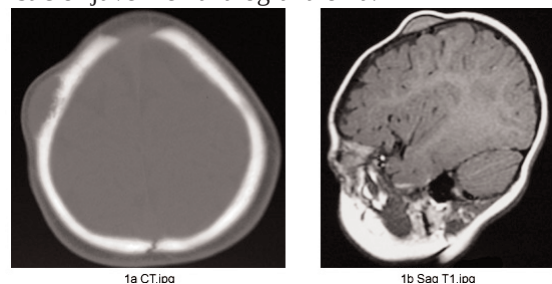


Figure (a) Axial CT reveals a subperiosteal mass with saucerization of the outer table of the calvarium, and mottled lytic destruction of the subjacent skull. (b) Sagittal T1-weighted MR image reveals that the tumor is mildly hyperintense compared with muscle.

CONCLUSION

Giant JXG can present occasionally as an isolated intracranial, spinal, or paraspinal lesion. These three cases appeared remarkably similar on MR imaging and resemble other cases reported in the literature. The low signal intensity on the T2-weighted images may be attributable to dense cellularity or collagenous matrix. Tumors that mimic the radiologic features of giant JXG include Langerhans cell histiocytosis, desmoid tumor, cellular schwannoma, and neuroblastoma. As this entity is exceptionally uncommon, the correct diagnosis was not anticipated preoperatively in any case. Awareness of this entity may be important to prevent unnecessary aggressive treatment.

KEY WORDS: Giant juvenile xanthogranuloma, children, non-Langerhans histiocytosis

Paper 139 Starting at 11:27 AM, Ending at 11:35 AM**Comparison of Gadobenate Dimeglumine with Gadopentetate Dimeglumine for Enhanced MR Imaging of Brain and Spine Tumors in Pediatric Subjects**

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¹University of Chieti, Chieti, ITALY, ²University of Leuven, Leuven, BELGIUM, ³Cardiff Research Center, Cardiff, UNITED KINGDOM, ⁴Bracco Diagnostics Inc, Princeton, NJ, ⁵Bracco Imaging SpA, Milan, ITALY

PURPOSE

Gadobenate dimeglumine (Gd-BOPTA, MultiHance®, Bracco Imaging SpA, Milan, Italy) is a paramagnetic contrast agent whose T1 relaxivity in vivo ($r_1 = 9.7 \text{ mmol} \cdot \text{L}^{-1} \cdot \text{s}^{-1}$) is approximately twice that of Gd-DTPA and other available gadolinium agents due to a capacity for weak and transient interaction with serum albumin. In adult subjects Gd-BOPTA provides significantly greater contrast enhancement of enhancing intraaxial brain tumors when compared to that achieved with Gd-DTPA, Gd-DOTA, and Gd-DTPA-BMA. A prospective interindividual study in 174 pediatric subjects with known or suspected CNS abnormalities previously demonstrated comparable safety and efficacy for Gd-BOPTA and Gd-DTPA. The present study qualitatively and quantitatively compares the enhancement achieved after Gd-BOPTA and Gd-DTPA in a subpopulation of 63 pediatric subjects with confirmed brain or spine tumors.

MATERIALS & METHODS

Sixty-three pediatric patients with confirmed tumors of the brain or spine received an 0.1 mmol/kg BW dose of either Gd-BOPTA (n = 29; 18 M/11 F, mean age 7.5 ± 4.8 years) or Gd-DTPA (n = 34; 13 M/21 F, mean age 7.9 ± 4.7 years). MR images were acquired before (T1-weighted and T2-weighted SE sequences) and within 10 min (T1-weighted SE sequences only) of contrast injection. Blinded unpaired (pre and postdose images evaluated separately) and paired (pre and postdose images evaluated together) qualitative assessments of technically adequate images in which lesions were found both pre and postcontrast (Gd-BOPTA: n = 24; Gd-DTPA: n = 31), were performed to compare pre to postdose changes in border delineation, visualization of internal morphology, and contrast enhancement by means of 4-point scales from 1 (poor) to 4 (excellent). Qualitative evaluations were performed by patient and by lesion (25 and 39 lesions

for Gd-BOPTA and Gd-DTPA, respectively). Quantitative evaluation of intraaxial brain tumors (22 lesions for Gd-BOPTA, 25 lesions for Gd-DTPA) compared changes in lesion-to-background ratio (L/B), contrast-to-noise ratio (C/N), and % enhancement (%En). Statistical comparison between groups was performed using t-tests at $p < 0.05$.

RESULTS

Unpaired postdose scores for lesion border delineation, visualization of internal morphology, and contrast enhancement were 3.3 ± 0.6 , 3.4 ± 0.6 , and 3.4 ± 0.6 for Gd-BOPTA, respectively, and 3.1 ± 0.7 , 3.4 ± 0.6 , and 3.1 ± 0.7 for Gd-DTPA, respectively. The pre to postdose changes were significantly superior for Gd-BOPTA compared to Gd-DTPA for border delineation ($p = 0.018$) and contrast enhancement ($p = 0.006$) and nonsignificantly superior for visualization of internal morphology ($p = 0.126$). Paired assessments revealed nonsignificant superiority for Gd-BOPTA for border delineation and visualization of internal morphology and significant superiority for contrast enhancement ($p = 0.04$). Significantly better performance for Gd-BOPTA was noted also for lesion-by-lesion assessments of border delineation and contrast enhancement ($p < 0.01$, all assessments). Mean postdose values for L/B, C/N, and %En were all superior for Gd-BOPTA compared to Gd-DTPA (0.5 ± 0.4 vs. 0.3 ± 0.4 ; 9.1 ± 15.4 vs. 2.2 ± 9.9 ; 66.6 ± 47.4 vs. 42.8 ± 39.0 , respectively).

CONCLUSION

Gd-BOPTA demonstrates significant superiority over Gd-DTPA for enhancement of brain and spine tumors in pediatric patients. The superior contrast enhancement can be attributed to the two-fold greater T1 relaxivity in blood of Gd-BOPTA and may be clinically advantageous for the detection and diagnosis of small or poorly enhancing tumors in subjects for whom other diagnostic imaging techniques may be less desirable.

KEY WORDS: Contrast agents, comparative studies, brain tumors

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of MultiHance (gadobenate dimeglumine) made by Bracco SpA for CNS imaging.

The authors of this work have indicated the following affiliations/disclosures: 1. Bracco Diagnostics Inc.: Employee; 2. Bracco Imaging SpA: Employee.

Paper 140 Starting at 11:35 AM, Ending at 11:40 AM**Combined Communicating Cephalhematoma and Epidural Hematoma: Treatment and Management Implications**

Emamian, S. • Vezina, G. • Keating, R.

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CT of head in an infant following forceps delivery demonstrated a large cephalhematoma communicating via a diastatic fracture to a large epidural hematoma causing midline shift and mass-effect. A smaller cephalhematoma was seen on the opposite side again communicating to a small epidur-

al hematoma without any significant mass effect. The neurosurgery team elected to treat the patient with percutaneous aspiration of the cephalhematoma, which resulted in decompression of the epidural hematoma as well. The parents and the personnel taking care of the patient were instructed to avoid applying pressure on the cephalhematomas. The residual hematomas underwent calcification on follow-up and the patient did not require craniotomy. Lesson: Do not compress a cephalhematoma that is associated with a fracture.

KEY WORDS: Cephalhematoma, epidural hematoma, cephalohematoma

Paper 141 Starting at 11:40 AM, Ending at 11:45 AM

Subdural Hematoma in the Pediatric Age Related to Roller-Coaster Ride: Case Report

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PURPOSE

Amusement park injuries and mishaps have long been considered newsworthy events, but these reports have become more common in the last several years. Since 1979 medical literature has published reports to that effect but they are few, quite varied, all related to roller-coaster rides and include: carotid and vertebral artery dissection, intracerebral hemorrhage, subdural hematoma, and spontaneous cerebrospinal fluid leaks. Most of the patients in these reports are adults. We present a case of subdural hematoma apparently due to a roller-coaster ride in the pediatric age with review of the literature.

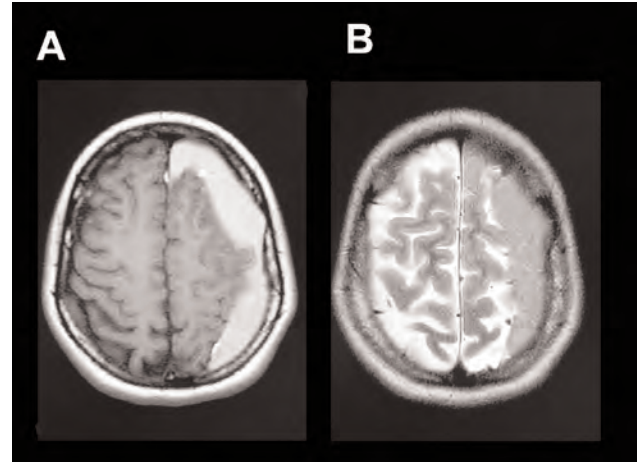
MATERIALS & METHODS

A 15-year-old girl presented to the emergency room complaining of recent right-sided paresthesias accompanied by a 2-week severe frontal headache following a roller-coaster ride. Physical examination revealed weakness on the upper right extremity and bilateral lower limb hyperreflexia. MR imaging showed a large frontoparietal subdural hematoma on the left side. The signal intensity was slightly heterogeneous in all sequences suggesting blood at different stages and possible active bleeding. Some degree of mass effect affecting the sulci existed, without midline deviation. Significant widening of the subarachnoid space at the convexity was noted on the right side, an abnormal finding given the patient's age. The patient was not known to have suffered from neonatal hypoxia nor any other risk factor to explain this finding. Surgery was performed successfully.

RESULTS

The new technologic advances and competition within the amusement industry has led to generation of dangerously high G forces that may be harmful. Unfortunately, few medical researchers have studied the specific physiopathologic effects that roller-coaster rides can induce. In this particular case we think that the widening of the subarachnoid space favored by some degree of dehydration given the summer season or high temperature climate, lead to the hematoma formation, since under these circumstances the brain is more prone to a certain amount of movement and internal trauma. In roller-coaster rides the brain is exposed to ups-and-downs,

to-and-fro, and rotatory acceleration, which produce tensile and shearing stresses, causing the brain to hit the skull on several occasions which favors tearing of the superficial bridging cerebral veins (known to arise in the substance of the brain that cross the subarachnoid and subdural space near their termination to pierce the dura), and, therefore resulting in subdural hemorrhage.



CONCLUSION

To our knowledge the previously published papers about this type of injury have not made an association between widened subarachnoid spaces or some degree of cerebral volume loss and a higher incidence of subdural hematoma. In any case everyone involved in this industry as well as the general population should be aware that giant roller coasters can cause subdural hematomas in normal or otherwise healthy individuals.

KEY WORDS: Roller-coaster ride, hematoma subdural, subarachnoid widening

Paper 142 Starting at 11:45 AM, Ending at 11:50 AM

Medullomyoblastoma: A Rare Pediatric Posterior Fossa Tumor

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²Children's Hospital of Pittsburgh, Pittsburgh, PA

PURPOSE

To present a case of surgically resected medullomyoblastoma, a rare posterior fossa tumor, and to describe clinico-pathologic and radiologic features along with treatment options.

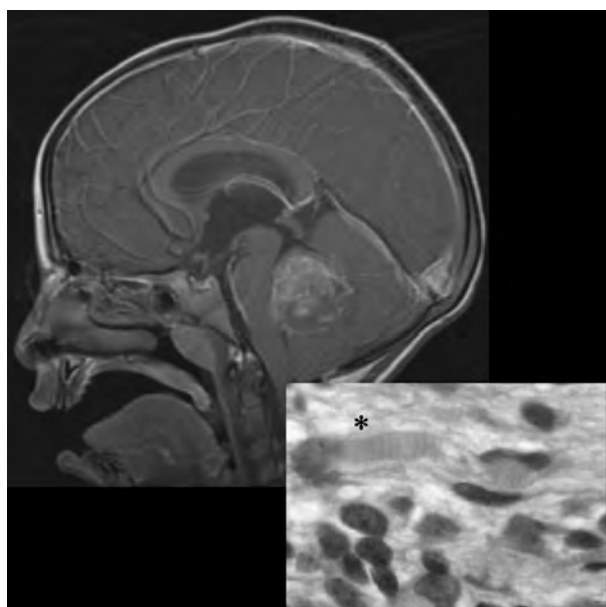
MATERIALS & METHODS

Information was obtained from the patient's medical record and was supplemented by patient and physician contact. MR images pre and postsurgery were reviewed and tumor was examined for immunohistochemical expression of synaptophysin, muscle-specific actin, and desmin.

RESULTS

This three-year-old male child presented with a 3-month history of progressive ataxia, lethargy, and slurred speech, and new onset of vomiting. MR examination revealed a heterogeneously enhancing mass in the fourth ventricle causing

obstructive hydrocephalus (Figure). There were hypointense areas within the tumor on T2 sequences. A suboccipital craniotomy was performed with near total resection of the tumor. At surgery, a purplish, fairly vascular tumor was seen, with substantial amount of invasion laterally along the cerebellar peduncles. Rostrally, the tumor blended into the cerebellar vermis. Pathologic examination revealed the presence of two components: medulloblastoma-like neuronal features, along with bundles of myoid cells. Immunohistochemical stains were positive for synaptophysin, MMF 35 (muscle-specific actin), and desmin, which confirmed the diagnosis of medulloblastoma; banded, skeletal muscle-like structures were seen on H&E; staining (Inset, asterisk). The patient had no evidence of tumor on spine MR imaging although both lumbar and ventricular CSF cytology were positive for tumor cells. Postoperative brain MR imaging showed postoperative changes without definite evidence of residual tumor. Chemotherapy was instituted with two courses of cisplatin and cyclophosphamide given 3 weeks apart followed by a 21-day course of oral etoposide. Because of the patient's young age, the chemotherapy is being used to either delay the need for or allow dose reductions in the craniospinal radiation.



CONCLUSION

Medulloblastoma is a very aggressive, rare variant of medulloblastoma, which has neuronal differentiation and skeletal muscle component. The histogenesis remains uncertain, though immunohistochemistry suggests origin from a multipotent stem cell precursor.

KEY WORDS: Medulloblastoma, pediatric, hydrocephalus

Tuesday Morning

10:15 AM - 11:45 AM

Room 602 - 603

(24) ELC Workshop C: Image Manipulation with Photoshop

— Richard M. Berger, MD

Tuesday Morning

11:50 AM - 12:50 PM

Room 611 - 612

(25) American Society of Pediatric Neuroradiology (ASPNR) Annual Business Meeting (Members Only)

Tuesday Afternoon

1:00 PM - 2:00 PM

Ballroom 6 A

(26) ELC Lecture E: Building a Multimedia Conference Room from Scratch

— Venkata Natarajan, PhD

Tuesday Afternoon

1:00 PM - 2:30 PM

Room 606 - 609

(27) ENT (ASPNR)

(27a) Congenital Masses of the Head and Neck

— *Suresh K. Mukherji, MD*

(27b) MR Spectroscopy of the Head and Neck

— *Suresh K. Mukherji, MD*

(27c) Pediatric Head and Neck Soft Tissue Masses

— *Bernadette L. Koch, MD*

(27d) Pediatric Head and Neck Osseous Lesions

— *Bernadette L. Koch, MD*

(27e) Discussion

Moderators: Caroline D. Robson, MB, ChB
Avrum N. Pollock, MD

palpable neck mass. At our institutions, MR imaging usually is reserved for patients with a neoplasm that can be confirmed on clinical examination. Patients with neoplasms involving the skull base usually undergo both CT and MR imaging prior to treatment. MR imaging also is performed to further characterize congenital craniofacial vascular malformation to determine whether these are "high-flow" vs "low-flow" lesions. This finding may be helpful in planning treatment with percutaneous sclerotherapy. Ultrasound is becoming more widely accepted modality for imaging pediatric neck masses. The noninvasiveness and short imaging time make a sonography an ideal method for the initial evaluation of pediatric neck masses. As a result, sedation is not required for initial diagnostic evaluation with ultrasonography. Specific indications for ultrasound include: 1. Identification of a drainable collection within an enlarged cervical lymph node (suppurative adenitis), 2. Confirm the presence of a palpable thyroglossal cyst and determine a normal thyroid gland prior to Sistrunk procedure, 3. Evaluation of 2nd branchial cleft cysts, 4. Evaluation of flow characteristics of congenital vascular malformations, 5. Noninvasive evaluation of suspected fibromatosis coli.

MR Spectroscopy of the Head and Neck

Suresh K. Mukherji, MD

LEARNING OBJECTIVES

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

- 1) Summarize recent investigations that have been performed to evaluate the 1H-MRS in SCCA
- 2) Examine on the potential clinical role of MRS in the extracranial head and neck

PRESENTATION SUMMARY

In vitro and in vivo investigations have suggested that proton MR spectroscopy (1H-MRS) may be helpful in providing metabolic information of abnormalities in the extracranial head and neck. Several investigations have suggested that assessment of the relative levels of choline (Cho) and creatine (Cr) can provide information that may help differentiate SCCA from nonneoplastic tissue and may provide information that helps assess response to nonsurgical organ preservation treatment protocols. Elevation of the Cho/Cr ratio appears to be a consistent finding for SCCA and has been demonstrated in cell culture and from tissue samples from the primary site and in metastatic lymph nodes. These in vitro findings also have been demonstrated in vivo. 1H-MRS analysis of SCCA performed at 1.5 T has demonstrated significant elevation of the Cho/Cr ratio in patients with tumors compared with normal tongue muscle. A complete review of 1H-MRS is outside the scope of this section and we refer the readers to several references that cover this topic.

Congenital Masses of the Head and Neck

Suresh K. Mukherji, MD

LEARNING OBJECTIVES

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

- 1) Summarize the CT, MR imaging, and sonographic findings for a variety of pediatric neck masses
- 2) Review the pediatric sedation guidelines used for CT and MR imaging at our institution and suggest an algorithm for the evaluation of children that present with neck masses

PRESENTATION SUMMARY

Both CT and MR imaging may be used to evaluate children with disorders involving the extracranial head and neck. The choice of the modality is based on a combination of factors that include: 1. Clinical history, 2. Age of the patient, 3. Type of sedation, and 4. Risks associated with the required sedation required. The short imaging time necessary to perform spiral CT has made this technique the primary modality for evaluating children with indeterminate neck masses. Many of these studies can be performed without sedation. MR imaging provides superior soft tissue characterization and multiplanar capabilities. However the length of study usually requires some form of sedation in children under the age of 6 years of age. CT is the study of choice for children presenting with suspected cervical infections or patients with

Pediatric Head and Neck Soft Tissue Masses

Bernadette L. Koch, MD

LEARNING OBJECTIVES

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

- 1) Identify the preferred imaging modality based on the clinical history and suspected diagnosis in a child with a solid neck mass
- 2) Determine a reasonable differential diagnosis based on the imaging findings and clinical presentation of the child with a solid neck mass

PRESENTATION SUMMARY

Neck masses are a common indication for imaging the pediatric patient. The most common cause is cervical adenitis. Other causes of solid neck masses in children include fibromatosis coli, hemangioma of infancy, neurofibroma, lymphoma, rhabdomyosarcoma, neuroblastoma and occasionally metastatic adenopathy. Ultrasound is the preferred imaging modality in infants with suspected fibromatosis coli, clearly demonstrating an enlarged sternocleidomastoid muscle without associated adenopathy. In children, most cervical adenopathy is secondary to inflammatory disease rather than neoplasm and most do not require imaging. When imaging is needed, cervical adenitis may be imaged with CT or US, depending on the question to be answered. To identify the entire extent of involvement of an inflammatory process of the neck, CT is preferred. If the question is simply to determine if a specific palpable node is suppurative, ultrasound is ideal at answering this question. Lymphadenitis may be secondary to viral disease (EBV, CMV, HSV, measles, HIV), bacterial disease (staphylococcus or streptococcus, cat scratch disease), mycobacterial disease (atypical mycobacteria more common than mycobacterium tuberculosis) or rarely fungal disease (cryptococcus, histoplasmosis, coccidiomycosis). Mycobacterial disease typically lacks associated strandy inflammation of the adjacent fat, may have central nodal necrosis and/or calcifications. Cat scratch disease should be considered if there is a history of exposure to cats, the scratch itself may have been 1-2 weeks prior to the development of adenopathy. If cervical adenopathy is associated with significant palatine tonsil and adenoid enlargement, especially in a teenager, EBV/mononucleosis should be considered. Hemangioma of infancy is thought to be a true neoplasm with endothelial proliferation which results in a proliferative phase lasting months to years, followed by an involutional phase with complete resolution in most cases by the age of 4-8 years. On CT there is a soft tissue mass that intensely enhances, without associated osseous erosion. MR imaging is the preferred imaging modality in these children, better able to visualize the high flow intralesional vessels as serpiginous flow voids. However many of these children are imaged without sedation using CT at our institution. Children with lymphoma may have bulky unilateral or bilateral adenopathy and usually are imaged with CT, in conjunction with CT of the chest/abdomen and pelvis. Children with rhabdomyosarcoma, particularly at the skull base may require CT to best evaluate osseous erosion and MR imaging to assess for intracranial extension. Patients with cervical neuroblastoma may have primary or metastatic disease and are imaged routinely with I-123 MIBG in addition to CT or MR imaging.

Pediatric Head and Neck Osseous Lesions

Bernadette L. Koch, MD

LEARNING OBJECTIVES

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

- 1) Review and assess the common and uncommon osseous lesions that involve the pediatric head and neck, with particular attention to the face
- 2) Distinguish a reasonable differential diagnosis of osseous lesions in the pediatric head and neck based on the imaging characteristics

PRESENTATION SUMMARY

Osseous lesions involving the head and neck in children include fibro-osseous lesions, odontogenic and nonodontogenic cysts, inflammatory disease with associated osseous erosion (paranasal sinus or dental origin), aneurysmal bone cyst, reparative granuloma/central giant cell granuloma, Langerhan cell histiocytosis and malignant lesions such as osteosarcoma, metastatic neuroblastoma, lymphoma, and Ewing's sarcoma. The majority of these lesions are imaged initially with CT, with MR imaging being a complementary modality. The most common fibro-osseous lesion is fibrous dysplasia which may be radiolucent, have a typical ground glass appearance or be primarily sclerotic, depending on the proportion of fibrous and osseous components that replace normal medullary bone. The most common odontogenic cysts are the periapical cyst, dentigerous cyst, and odontogenic keratocysts. Periapical cysts are usually incidental findings. Dentigerous cysts are epithelial lined cavities that form in the follicular space of an unerupted tooth after crown formation is complete. When they occur in the maxilla, a tooth will be identified within the cyst which is projecting into the maxillary antra. A thin rim of bone should separate the cyst from the sinus. Odontogenic keratocysts are believed to originate from rests of dental lamina and are most commonly located in the mandible. Basal cell nevus syndrome (Gorlin-Goltz syndrome) is an autosomal dominant disorder characterized by multiple odontogenic keratocysts, basal cell carcinomas, skeletal anomalies, ectopic soft tissue calcifications, and extensive intracranial dural calcifications. Aneurysmal bone cysts are nonneoplastic in origin, composed of multiple blood-filled cysts with honeycombed fibro-osseous septations. The classic imaging appearance is that of an expansile multiloculated lesion with fluid-fluid levels. Central giant cell granuloma most commonly occurs in the midline mandible however may also occur in the maxilla. The etiology is uncertain, may be related to abnormal healing process rather than primary bone lesion. Langerhan cell histiocytosis in the head and neck may occur in the orbit, temporal bone, mastoids, maxilla or mandible. On imaging, it typically is well defined with an enhancing soft tissue mass. The classic beveled edge appearance of skull lesions is not always present. When it occurs in the maxilla or mandible there may be the typical "floating tooth" appearance. Osteosarcoma of the head and neck may be primary or secondary to prior radiation exposure, imaging appearance in the head and neck similar to other locations with aggressive osseous destruction and periosteal reaction. Metastatic neuroblastoma involving the osseous head and neck structures is identified most commonly involving the skull base or orbits, but may be focal involving the mandible or maxilla.

Discussion

Tuesday Afternoon

1:00 PM - 2:30 PM
Ballroom 6 B/C

(28) Advanced CT and MR Imaging of the Skull Base (ASHNR)

(28a) Anterior Skull Base Lesions

— Timothy L. Larson, MD

(28b) Central and Posterior Skull Base Lesions

— H. Ric Harnsberger, MD

(28c) Craniovertebral Junction

— Wendy R.K. Smoker, MD, FACR

Moderators: Jane L. Weissman, MD
Wendy R.K. Smoker, MD, FACR

Anterior Skull Base Lesions

Timothy L. Larson, MD

LEARNING OBJECTIVES

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

- 1) Discuss specific head and neck/sinonasal lesions that extend to involve the ACF
- 2) Differentiate extension to the ACF from lesions that arise within the ACF
- 3) Identify and review the workup of CSF rhinorrhea

PRESENTATION SUMMARY

This talk will review the more common Head and Neck disease processes that can lead to involvement of the ACF. Disease processes originating from within the ACF will not be discussed to any significant extent with the exception of CSF rhinorrhea.

- A. Head and neck anatomy pertinent to the ACF.
- B. Nonneoplastic lesions with potential involvement of the ACF: 1. Sinusitis - osteomyelitis, epidural/brain abscess, venous thrombosis; 2. Polyps/Polyposis; 3. Fungal Sinusitis [i. Mucocoele; ii. Fibro-osseous Lesions (a. Fibrous Dysplasia; b. Ossifying Fibroma; c. Osteoma)].

- C. Neoplastic Lesions: 1. Epithelial Sinonasal Malignancies; 2. Meningioma; 3. Esthesioneuroblastoma; 4. Sinonasal Undifferentiated Carcinoma; 5. Hemangiopericytoma; 6. Chondrosarcoma/Osteosarcoma; 7. Metastases; 8. Other Miscellaneous Tumors.
- D. CSF Rhinorrhea.

Central and Posterior Skull Base Lesions

H. Ric Harnsberger, MD

LEARNING OBJECTIVES

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

- 1) Describe central and posterior skull base imaging anatomy
- 2) Develop location-based differential diagnoses for central and posterior skull base
- 3) Recognize clinical-imaging feature of major lesions of the clivus, petro-occipital fissure, jugular foramen and petrous apex

PRESENTATION SUMMARY

In this presentation we will review the radiologic issues surrounding the central and posterior skull base. Imaging techniques and goals will be covered first. A combination of focused, thin-section enhanced skull base MR imaging and unenhanced, bone-only CT creates a complete imaging perspective of most skull base lesions. CT and MR normal anatomy required for complete image interpretation of skull base lesions is presented next. A careful look at the anatomy of the basi-sphenoid, basi-occiput, petrous apex, and jugular foramen is completed. Armed with this anatomical foundation, classic anatomy-based imaging differential diagnoses will be covered. These include differential diagnoses of clival, petro-occipital fissure, jugular foramen, and petrous apex lesions. Principal lesions discussed in this talk include clival chordoma, petro-occipital fissure chondrosarcoma. In the area of the jugular foramen, flow pseudolesions, jugular bulb venous variants and jugular foramen paraganglioma, schwannoma and meningioma will be highlighted. Finally, in the petrous apex trapped fluid, cephalocele, apical petrositis, cholesterol granuloma, Langerhans cell histiocytosis, and metastatic tumor will be presented.

REFERENCES

1. Moore KR, Fischbein NJ, Harnsberger HR, et al. **Petrous Apex Cephaloceles.** *AJNR Am J Neuroradiol* 2001;22:1867-1871
2. Moore KR, Harnsberger HR, Shelton C, et al. **"Leave Me Alone" Lesions of the Petrous Apex.** *AJNR Am J Neuroradiol* 1998;19:733-738
3. Ginsberg LE. **Neoplastic Diseases Affecting the Central Skull Base: CT and MR Imaging.** *AJR Am J Roentgenol* 1992;159:581-589

Disclosure: The author of this presentation has indicated an affiliation with Amirsys, Inc: Stock Options.

Craniovertebral Junction

Wendy R.K. Smoker, MD, FACR

LEARNING OBJECTIVES

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

- 1) Describe the normal anatomy of this region including normal CVJ relationships
- 2) Summarize the gamut of symptoms associated with CVJ pathology
- 3) Define common CVJ developmental abnormalities
- 4) Recognize systemic conditions that can affect the CVJ

PRESENTATION SUMMARY

The craniovertebral junction (CVJ) is a collective term that refers to the occiput, atlas, and the axis. It is important to recognize that CVJ pathology may produce ENT symptoms (vertigo, tongue atrophy, hearing loss) that may prompt the patient to seek primary care from an otolaryngologist who may not even be aware that CVJ pathology could produce these symptoms. Evaluation of this region requires identification of only a few anatomical landmarks, knowledge of osseous relationships, and some basic measurements. Important lines and angles used for CVJ craniometry are reviewed in this presentation including Chamberlain's line, Wackenheim's clivus baseline, Welcher's basal angle, and the atlanto-occipital joint axis angle. Pathology involving the CVJ may produce basilar invagination (congenital), basilar impression (acquired), platybasia (anthropomorphic term associated with invagination or impression, or cranial settling (associated with rheumatoid arthritis). The differences among these are explained and correct usage of these terms is presented.

Tuesday Afternoon

1:30 PM - 2:30 PM
Room 602 - 603

(28A) National Library of Medicine:
PUBMED[®]/MEDLINE Advanced Tips
and Tricks Hands-on Workshop

— Linda Milgrom

Tuesday Afternoon

3:00 PM - 4:33 PM
Ballroom 6 B/C

(29a) Adult Brain: Vascular Imaging
(Scientific Papers 143 - 154)

See also Parallel Sessions

(29b) Adult Brain: Functional Imaging (fMRI, MSI, MRS, PET)

(29c) Adult Brain: New Techniques, Postprocessing/Trauma

(29d) Pediatrics: General

Moderators: Raymond F. Carmody, MD
John R. Hesselink, MD

Paper 143 Starting at 3:00 PM, Ending at 3:08 PM

Intracranial Contrast-Enhanced MR Angiography at 3.0 T

Futterer, S. • Carroll, T. • McCarthy, R. • Carr, J.

Northwestern University
Chicago, IL

PURPOSE

The purpose of this study is to compare the signal-to-noise ratio (SNR) and vessel conspicuity of 1.5 T and 3.0 T contrast-enhanced MRA (CE MRA) exams of the intracranial vasculature.

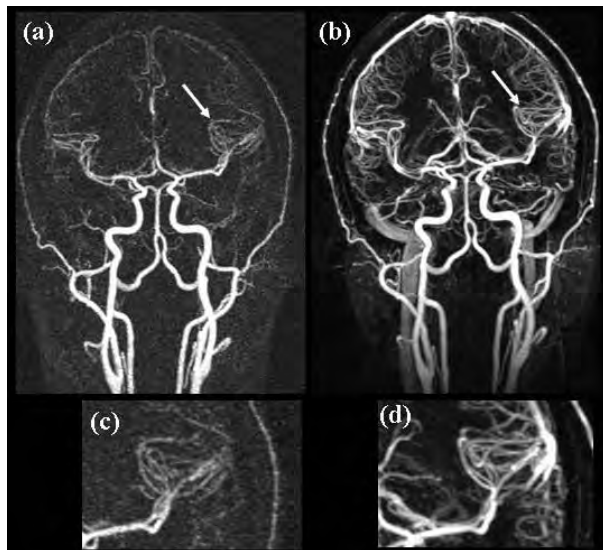
MATERIALS & METHODS

Subjects: Five healthy subjects including three women and two men (mean age = 31.4 years, range = 22-42 years) were scanned at both 1.5 T and 3.0 T. Imaging sessions were separated in time by 7 to 14 days. Image acquisition: Images were acquired on a 1.5 T Siemens Sonata and 3.0 T Siemens Trio within 14 days of each other. Images acquisition was coordinated with the arrival of bolus of contrast using a standard dose-timing scan (axial, 2D FLASH, one image/sec, 2.0 ml Gd-DTPA injected at 3.0 ml/sec) acquired at the level of the carotid bifurcation. The CE MRA images were acquired with the clinical intracranial MRA protocol used at our institution. Images were acquired in the coronal plane with a 3D FLASH, sequence (TR/TE/flip = 3.4 ms/1.3 ms/20°). One precontrast and 2 postcontrast images were acquired with inline mask-mode subtraction. In all exams, the field of view, imaging matrix, number of partitions, and partition thickness were held fixed (FOV = 169 mm x 300 mm) to yield a fixed voxel size of 0.6 mm x 1.0 mm x 0.8 mm³. In all exams, 18 ml of contrast were injected at a rate of 3.0 ml/s, independent of body weight. Image analysis: The images acquired at 1.5 T and 3.0 T were evaluated independently by two board-certified radiologists. The SNR of the CE MRA images was

evaluated by placing separate regions of interest over the carotid siphon and proximal internal carotid artery. Signal-to-noise ratio was calculated and the mean signal/standard deviation of the noise. In addition, images were scored on a four-point scale for vessel conspicuity of the Sylvian fissure branches and the more distal branches of the middle cerebral arteries.

RESULTS

Representative images comparing 1.5 T and 3.0 T CE MRA exams in the same subject appear in Figure 1. The anticipated increase in SNR at high field results in improved detection of distal MCA branches. This has implications for detection of vascular disease beyond the circle of Willis. Mean scores for SNR in the carotid siphon were 37.1 (69.0) for the 1.5 T (3.0 T) images. For the proximal ICA, SNR was 31.7 (50.5) for the 1.5 T (3.0 T) images. The scores for the SF/DCB/IQ were 2.8/1/6/2.8 for the 1.5 T exams and 3.4/2.4/3.4 for the 3.0 T exams.



CONCLUSION

Preliminary results suggest that MRA at 3 T produces improvements compared to 1.5 T. However, direct comparison of 1.5 T and 3.0 T images potentially could be a result of improvements in coil design.

KEY WORDS: Intracranial, MR angiography

Paper 144 Starting at 3:08 PM, Ending at 3:16 PM

Intracranial Aneurysms in Patients with Coarctation of the Aorta: A Prospective MR Angiography Study of One Hundred Patients

Huston, J. • Connolly, H. M. • Brown, R. D. • Warnes, C. A. • Ammash, N. M. • Tajik, A.

Mayo Clinic
Rochester, MN

PURPOSE

While the association between coarctation of the aorta (CoA) and intracranial arterial aneurysm (IA) has been reported, the exact incidence of IA in association with CoA is unknown and has not been evaluated systematically. In an attempt to

determine the prevalence of IA among 100 referral patients with operated and unoperated CoA, we evaluated these patients using cranial MR angiography (MRA).

MATERIALS & METHODS

With IRB approval, patients with a history of operated or unoperated CoA who were 18 years of age or older at the time of screening were included. Patients with contraindications for MRA screening and individuals who were not able personally to give informed consent were not included. MRA exams were performed with a three-dimensional time of flight sequence acquired with 3 axial slabs of 32 sections per slab, with 1.4 mm thick sections. The TR/TE was 36/6.9 ms. A ramped RF pulse with a central flip angle of 25 degrees was used. The field of view was 180 x 180 mm, and the prescribed matrix was 256 x 224. The scan time was 11 minutes and 28 seconds. Exams were reviewed by 2 independent blinded reviewers and discrepancies were adjusted with a consensus interpretation.

RESULTS

Ten patients (10%) were found to have IA (95% CI 5-18%), mean size 3.5 mm, (range 2-8). Intracranial aneurysms occurred in nine asymptomatic patients and one in a patient with a history of ruptured intracranial aneurysm treated with surgical clipping. Multiple IAs were detected in one patient. The frequency of IA was significantly higher than predicted in general population (10% vs 1-2% respectively, $p < 0.001$). One patient with an 8 mm diameter basilar tip aneurysm considered to have a higher long-term rupture risk than conservative management risk underwent conventional angiography and surgical clipping. Nine patients are being followed medically with risk factor control and repeat imaging in 6 to 12 months.

CONCLUSION

There is at least a 5-fold increase in frequency of IA in patients with coarctation of the aorta compared to general population. MR angiography screening detects IA in approximately 10% of patients with CoA. Most IAs detected were small and are being followed but aneurysm treatment was recommended in one patient. These data suggest that cerebral MRA screening in patients with CoA should be considered seriously.

KEY WORDS: Aneurysm, MR angiography, coarctation

Paper 145 Starting at 3:16 PM, Ending at 3:24 PM

Does Digital Subtraction Angiography Provide a Benefit to Patients with Subarachnoid Hemorrhage, an Aneurysm Identified on CT Angiography, and a Hemorrhage Pattern Compatible with the Aneurysm Location?

Uhrbrock, D. H. • Pitt, A.

Barrow Neurological Institute
Phoenix, AZ

PURPOSE

To evaluate the benefits of angiography on patients with subarachnoid hemorrhage who have an aneurysm identified on CT angiography (CTA) and a hemorrhage pattern that is compatible with the aneurysm location.

MATERIALS & METHODS

Retrospectively, reports of 167 patients who presented with unexplained subarachnoid hemorrhage were reviewed. One hundred fifty-eight of the patients underwent CTA. Of the 158 patients, 90 patients with an aneurysm found by CTA, compatible hemorrhage pattern, digital subtraction angiography (DSA) imaging and surgical confirmation were selected for analysis.

RESULTS

In 90 patients with an aneurysm found by CTA, compatible hemorrhage pattern, digital subtraction angiography imaging, and surgical confirmation, 85 (94.4%) showed no benefit from DSA. In five patients, additional small aneurysms were found by DSA that were not identified by CTA. The additional discovered aneurysms were 3 mm or less in diameter and in three patients, were located in the cavernous portions of the internal carotid arteries, a challenging diagnostic location for CTA. In one patient, DSA discovered a 1 mm ophthalmic aneurysm which was not identified on CTA. In another patient, DSA discovered additional mycotic aneurysms that were not appreciated on CTA.

CONCLUSION

When weighing the risks and benefits of DSA in patients with CTA-proven aneurysm and a hemorrhage pattern consistent with the aneurysm location, the risks of DSA are not justified for the incremental gain in aneurysm detection. Digital subtraction angiography remains beneficial in patients with CTA-negative SAH and in patients in which the hemorrhage pattern does not correlate with the location of the aneurysm discovered by CTA.

KEY WORDS: CT angiography, digital subtraction angiography, subarachnoid hemorrhage

Paper 146 Starting at 3:24 PM, Ending at 3:32 PM

Arterial Blood Pressure Measurements in the Feeding Arteries of Brain Arteriovenous Malformations: Correlation with Clinical Presentation and Angioarchitecture

Vilela, P. F. • Goulao, A.

Garcia de Orta Hospital
Lisbon, PORTUGAL

PURPOSE

The authors correlate the brain arteriovenous malformations (AVMs) hemodynamics by measuring the blood pressure in pial arterial feeders, the clinical presentation and the angioarchitecture of the brain AVMs.

MATERIALS & METHODS

Seventy-one consecutive patients with AVMs were evaluated prospectively. Twenty-seven (38%) AVMs had hemorrhagic and 44 (62%) nonhemorrhagic presentation. Feeders' arterial pressure (FAP) measurements were obtained by placing a microcatheter as close to the nidus as possible while the mean arterial pressure (MAP) was being recorded simultaneously. A total of 308 AVM's feeding arteries were evaluated and 4 groups were defined in relation to the value blood pressure differential given by the formula $[F = (MAP - FAP)/MAP]$: Group I: $F < 0.3$; Group II: $0.30 \leq F \leq 0.45$; Group III: $0.45 < F \leq 0.60$; Group 4: $F > 0.6$. Univariable

analysis for dependency with Chi-square Pearson test and for association with linear/linear or likelihood ratio and multivariable analysis with logistic regression for prediction of hemorrhage/nonhemorrhage based on the feeder's pressure differential and angioarchitecture were performed.

RESULTS

In the univariable analysis there was as a statistically significant ($p < 0.001$) dependency/association between Grade I feeder's and brain AVMs with hemorrhagic presentation, infratentorial location, size < 3 cm, venodural stenosis, deep venous drainage, perinidal angiogenesis; and between Grade IV feeder's and nonhemorrhagic presentation. In the multivariable logistic regression model AVMs with feeders with higher pressure and deep venous drainage had more frequently hemorrhagic presentation.

CONCLUSION

Brain AVMs have a large individual heterogeneity regarding the feeding arteries resistance and flow, but there is a significant association between the pressure (feeders) B-AVM system and clinical presentation with higher risk for hemorrhagic presentation in higher pressure systems.

KEY WORDS: Brain arteriovenous malformation, arterial pressure, hemorrhage

Paper 147 Starting at 3:32 PM, Ending at 3:40 PM

An In Vitro Simulator for Measuring and Visualizing Hemodynamics in Human Vessels

Isoda, H.¹ • Nishino, K.² • Kosugi, T.³ • Takeda, S.⁴ • Inagawa, S.¹ • Isogai, S.¹ • Sakahara, H.¹

¹Hamamatsu University School of Medicine, Hamamatsu, JAPAN, ²Yokohama National University, Yokohama, JAPAN, ³Renaissance of Technology Corporation, Hamamatsu, JAPAN, ⁴Nexus Inc., Tokyo, JAPAN

PURPOSE

Hemodynamics plays very important roles in the development and growth of intracranial aneurysms, abdominal aortic aneurysms, and carotid stenoses. However, there is no well established in vivo or in vitro hemodynamics measuring system in human vessels at present. The purpose of our study was to establish an in vitro simulator for measuring and visualizing hemodynamics in human vessels, characterized by a realistic hollow silicon vessel model based on a clinical imaging data set and refraction index matching between the silicon model and a flowing fluid.

MATERIALS & METHODS

Multiple 2-dimensional (2D) slices of arteries in each patient were obtained with the use of clinical imaging such as mr angiography, CT angiography or rotational digital subtraction angiography. These DICOM data sets were processed to reconstruct the lumen of the vessels in three dimensions, and then transferred to a 3-dimensional (3D) printer using powders and adhesive to produce a master cast of the vascular lumen. Based on this master cast, a realistic silicon model containing the lumen of the original vessels then was constructed. We completed refraction index matching between the silicon model and an aqueous solution of glycerol. The silicon model was placed into a container containing the index-matched fluid. We ran the index-matched fluid, in

which tiny nylon tracer particles with diameter of about 30 microns were suspended, through the silicon vessel model by a centrifugal pump. Images of flowing particles through the lumen of the silicon model were taken with a monochromatic NTSC camera and a double-pulsed Nd:YAG laser (wave length, 532 nm; power, 30m J/pulse; interval between double pulses, 50 microseconds). These images clearly showed particles flowing along the vessel wall suggesting accurate refraction index matching between the silicon model and the flowing fluid. Velocity maps were obtained with particle image velocimetry analysis.

RESULTS

We established an in vitro simulator for measuring and visualizing hemodynamics in human vessels, characterized by the following: 1) obtaining multiple 2D slices including human vessels with the use of a clinical imaging scanner; 2) calculation of 3D vessel data sets by a computer based on clinical data sets; 3) production of a realistic hollow silicon vessel model using previous computer data sets and 3D printing using powders and adhesive; 4) completion of refraction index matching between the silicon model and an aqueous solution of glycerol; 5) whole field measurement of hemodynamics in the model by using particle image velocimetry.

CONCLUSION

This simulator enabled us to obtain, as realistically as possible, tailor-made hemodynamics in patients' pathologic vessels.

KEY WORDS: Human vessels, hemodynamics, particle image velocimetry

The authors of this work have indicated the following affiliations/disclosures: 1. Renaissance of Technology Corporation: Employment; 2. Nexus, Inc.: Employment.

Paper 148 Starting at 3:40 PM, Ending at 3:48 PM

Follow-Up of Coiled Cerebral Aneurysms at 3 T: Comparison of Three-Dimensional Time-of-Flight MR Angiography at 3 T vs Three-Dimensional Time-of-Flight MR Angiography and Gadolinium-Enhanced MR Angiography at 1.5 T

Anzalone, N. • Righi, C. • Politi, L. S. • Iadanza, A. • Cadioli, M. • Scotti, G.

Scientific Institute HSRaffaele
Milan, ITALY

PURPOSE

To verify feasibility of three-dimensional (3D) time-of-flight (TOF) MR angiography (MRA) of coiled aneurysms at 3 T and to compare it with 3D TOF MRA and ultrafast gadolinium MRA at 1.5 T.

MATERIALS & METHODS

Twelve patients treated with Guglielmi detachable coils (GDC) for cerebral aneurysms were studied at 3 T (Intera, Philips) and 1.5 T (Intera, Philips) within 24 hours from each other. At 3 T 3D TOF MRA studies were performed with a head T/R coil and an axial acquisition (TR 23, TE 3.2, FOV 200, acquisition voxel size: 0.50 x 0.50 x 1 mm). At 1.5 T a Sensitivity encoding (SENSE) head coil was used; a 3D TOF

axial acquisition was performed first (SENSE factor 2, TR 23, TE 3.6, FOV 220, acquisition voxel size: 0.72 x 0.72 x 1 mm), followed by an axial 3D ultrafast (24 sec) gradient-echo sequence (SENSE factor 2, TR 6.1, TE 2.1, FOV 220, acquisition voxel size: 0.72 x 0.72 x 0.80 mm) after a bolus of 0.2 ml/kg of gadolinium. All studies were evaluated with both MIP and SSD reconstructions targeted on the vessel of interest. Source images were considered as well. Digital subtraction angiography examination was performed in presence of suspected residual aneurysm patency on MRA.

RESULTS

Twelve aneurysms (7 anterior communicating artery, 3 internal carotid artery, 2 basilar artery) were evaluated. Presence of coil artifact was equally evident on both 3 T and 1.5 T 3D TOF acquisitions, whereas it was not appreciable on gadolinium MRA. The coil artifact did not affect in both 3 T and 1.5 T the identification of aneurysm parent artery or residual aneurysm patency. In 7 out of 12 cases the presence of a remnant or recurrence was detected and successively confirmed by DSA. In all these cases gadolinium MRA better demonstrated the residual patency of the treated aneurysm; nevertheless 3 T 3D TOF MRA showed a higher signal and a sharp definition of the parent vessel and residual aneurysm patency in comparison with 1.5 T 3D TOF MRA.

CONCLUSION

Our data though preliminary, demonstrate that MRA follow-up of coiled aneurysms is feasible at 3 T and is better than at 1.5 T; nevertheless ultrafast targeted gadolinium MRA at 1.5 T demonstrates the higher definition of the residual patency.

KEY WORDS: Aneurysm cerebral, MR angiography, 3 T

Paper 149 Starting at 3:48 PM, Ending at 3:56 PM

Intraoperative Doppler Ultrasound as a Guide to Surgical Removal of Cerebral Arteriovenous Malformation

Pozniak, M. A. • Dempsey, R. J. • Mitchell, C. C.

University of Wisconsin Madison
Madison, WI

PURPOSE

Evaluate the efficacy of intraoperative spectral and color Doppler ultrasound to guide and confirm completeness of ablation of arteriovenous malformations (AVM).

MATERIALS & METHODS

Twenty patients (17-53 years old) (9 male-11 female) underwent surgical resection of cerebral AVM. Preoperative assessment included functional MR imaging, CT, or angiography. Some patients had selective embolization of nidus and feeders. At surgery MR-based stereotactic localization was applied for patient positioning and defining the craniotomy flap. Intraoperative Doppler was used to define the location and extent of the lesions. Spectral Doppler flow resistance patterns helped identify vessels that were essential only to the AVM and confirm complete removal of the entire lesion.

RESULTS

Intraoperative color Doppler ultrasound proved consistently more precise than stereotactic localization of the AVM due to brain shift after craniotomy and retraction. Reexamination during the course of the procedure helped focus and limit the surgical dissection. Examination after presumed extirpation revealed residual nidus in two cases allowing timely complete removal. Intraoperative angiography was performed on several cases but with increased confidence in the Doppler exam we were able to forgo the intraoperative angiogram. Postoperative angiography confirmed excellent results with total removal in all patients.

CONCLUSION

Intraoperative spectral and color Doppler ultrasound provides a more focused surgical approach to the intracranial AVM, accurately determines completeness of resection, and obviates the need for intraoperative angiography.

KEY WORDS: Doppler ultrasound, AV malformation, intraoperative

Paper 150 Starting at 3:56 PM, Ending at 4:04 PM

Contrast-Enhanced Angiography of Intracranial Venous Vessels and Sinuses: An Application of MR Parallel Acquisition Technique

Gawehn, J.¹ • Tintera, J.² • Ringel, K.¹ • Stoeter, P.¹

¹Institute of Neuroradiology, Mainz, GERMANY, ²Institute for Clinical and Experimental Medicine, Prague, CZECH REPUBLIC

PURPOSE

MR angiography of the intracranial venous vessels usually is computed from data sets of 2D or 3D phase-contrast imaging or from contrast-enhanced time-of-flight data. Nevertheless, the acquisition of 3D data sets is time-consuming, and flow phenomena sometimes cause misinterpretations, especially in case of sinus thrombosis. Parallel acquisition technique in combination with an intravenous bolus application of a contrast agent allows direct depiction of the perfusion of venous vessels.

MATERIALS & METHODS

Twenty-six patients were examined to analyze their venous drainage, among them 13 because of suspected sinus thrombosis, 6 because of drainage in case of meningiomas, 1 because of regional swelling after resection of a meningioma, 1 because of intracranial manifestation of a plasmocytoma and suspicion of sinus occlusion. Data acquisition was performed by FLASH 3D coronal, 72 slices with 2 mm thickness, TR/TE/Flip 3.14 ms/1.35 ms/20°, FoV 230 mm, basic resolution 384, phase resolution 50%, slice resolution 63%, parallel acquisition with GRAPPA, factor 3, reference lines 48. Each measurement consisted of 8 repetitions of a sequence, total acquisition time 61s. Intravenous bolus application of 20 ml Magnevist with 4 ml/s. Postprocessing by subtraction of pairs of the sequences and 3D visualization. 1.5 T Siemens Sonata, 8-channel array head coil. All results were referenced by phase-contrast imaging or invasively by digital subtraction angiography.

RESULTS

Intracranial sinuses and vessels were depicted with high contrast-to-noise ratio and with high anatomical resolution in all patients. Superpositions of arteries could be avoided completely by subtraction. In all cases a definite decision about sinus thrombosis was possible. Moreover, venous bypass pathways were displayed, and dynamic analysis of blood flow is demonstrated by subtraction between different sequences. In meningiomas pathologic drainage was identified easily (Figure). Occlusion or stenosis of adjacent sinuses could be verified in excellent conformity with DSA controls.



Figure. Venous drainage of a hemangiopericytoma.

CONCLUSION

Venous CE angiography with parallel acquisition technique is an excellent method to visualize intracranial venous vessels and is especially recommended to evaluate sinus thrombosis. It is as well suited to display the venous drainage of meningiomas. Performance is quick and quality superior to phase contrast images.

KEY WORDS: Contrast-enhanced angiography, sinus thrombosis, PAT

Paper 151 Starting at 4:04 PM, Ending at 4:12 PM

Autonomic Dysfunction-Induced Hypertensive Encephalopathy

Gkogkas, C. • Klufas, R. A. • Henderson, G. V. • Feske, S. K. • Schwartz, R. B.

Brigham and Women's Hospital
Boston, MA

PURPOSE

The syndrome of hypertensive encephalopathy (HTE) is characterized by headache, seizures, and neurologic signs, usually in the setting of rapid elevation of blood pressure (1). CT and MR imaging typically show reversible edema, most commonly in the subcortical occipito-parietal white matter. Disturbances of autonomic function can result from spinal cord lesions above T6 (i.e., above the major splanchnic sympathetic outflow), as well as with acute demyelination of the

sympathetic and parasympathetic fibers, and can lead to acute hypertension and subsequent development of HTE. We present the radiologic and clinical data of two patients with Guillain-Barre syndrome and three patients with spinal cord lesions with autonomic dysfunction resulting in HTE.

MATERIALS & METHODS

The clinical and radiologic data of 121 patients with HTE admitted in our hospital between January 1990 and May 2003 were reviewed. Three patients in this group had the clinical diagnosis of high thoracic or cervical myelopathy, resulting in autonomic dysreflexia, and two patients with acute Guillain-Barre syndrome developed dysautonomia. For each patient, the mean arterial blood pressure [MAP (max)] at the time of the neurologic event was recorded, as was the MAP at a time remote from the neurologic event when the patient was asymptomatic [MAP (bl)].

RESULTS

Patient 1: 24-year-old man with posttraumatic thoracic aortic transection and a T₄ myelopathy presented with headaches and seizures. The MAP (bl) in mm Hg, was 107 and MAP max was 167. Patient 2: 73-year-old woman with acute T₂ spinal cord compression from metastatic lung disease had headache, visual agnosia, and seizures. The MAP (bl) was 90 and the MAP (max) was 128. Patient 3: 37-year-old man with chronic traumatic C₅ myelopathy developed a urinary tract infection and presented with headaches and seizures. The MAP (bl) was 77 and MAP (max) was 140. Patient 4: 66-year-old woman with Guillain-Barre syndrome and rapid development of somnolence. The MAP (bl) was 106 and the MAP (max) was 130. Patient 5: 50-year-old woman with Guillain-Barre syndrome complicated by respiratory failure. The MAP (bl) was 107 and MAP (max) was 167. On CT and MR imaging, subcortical white matter edema in the occipital lobes bilaterally was seen in all patients; other involved regions included the parietal and posterior frontal lobes, cerebellum, and the splenium of the corpus callosum.

CONCLUSION

Based on consistent clinical features and neuroimaging studies, the symptoms of headaches, seizures, or encephalopathy encountered in autonomic dysreflexia and dysautonomia are most likely secondary to hypertensive encephalopathy. Cognizance of this association should lead to rapid diagnosis and treatment of these patients.

REFERENCES

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KEY WORDS: Hypertensive encephalopathy, spinal cord injury, Guillain Barre syndrome

Paper 152 Starting at 4:12 PM, Ending at 4:20 PM

CT Angiography vs Digital Subtraction Angiography in the Assessment of Residual Aneurysm after Open Surgical Clipping

Tzung, B. S.¹ • Walker, M. T.¹ • Tsai, J.¹ • Futterer, S. F.¹ • Curtin, K. C.¹ • Shaibani, A.¹ • Bendok, B.¹ • Krupinski, E.² • Krupinski, E.² • Russell, E. J.¹

¹Northwestern Memorial Hospital, Chicago, IL, ²University of Arizona, Tucson, AZ

PURPOSE

Digital subtraction angiography (DSA) is the gold standard examination to evaluate residual or recurrent aneurysm after surgical clipping. The role of CT angiography (CTA) in this setting has not been defined in part due to the artifact produced by aneurysm clips in a CT scanner. The purpose of this study was to assess the clinical value of CTA in identifying residual aneurysms, and to evaluate whether CTA could be effective as a stand-alone study for any particular subset of patients.

MATERIALS & METHODS

Thirty-nine consecutive patients with 50 aneurysms were included in the study. Each patient underwent surgical clipping of at least one aneurysm followed by CTA and DSA examinations to evaluate for recurrent or residual aneurysm. CT angiography was performed on a 4-slice scanner (GE, Lightspeed) acquired at 2.5 x 1.25 mm and reconstructed and reviewed at 1.25 x 0.625 mm in the axial, coronal, and sagittal planes. The DSA exams were consensus read by two neuroradiologists and one neurosurgeon that was trained in endovascular surgical neuroradiology. The DSA examinations were considered the gold standard. The number of aneurysm clips and the size of the remnant aneurysm were identified. Three board-certified, CAQ certified neuroradiologists experienced in CTA interpretation independently evaluated each CTA exam for residual aneurysm in a blinded fashion. Readers assessed each case based upon a 6-point scale: 1 = remnant present: definite; 2 = remnant present: probable; 3 = remnant present: possible; 4 = remnant absent: possible; 5 = remnant absent: probable; 6 = remnant absent: definite. A 3-point scale was used to rate the reader's perception of the amount of artifact produced by the aneurysm clips: 1 = mild artifact; 2 = moderate artifact; 3 = severe artifact. Sensitivity and specificity were calculated for each reader and for all readers combined. Results were analyzed further by size and number of clips present. The Student's t-test (unpaired, one tail) was used for statistical significance.

RESULTS

Digital subtraction angiography consensus readings identified 16 remnants out of the 50 aneurysms clipped. Overall, sensitivity and specificity of CTA for remnant aneurysm were 48 % (range, 44-56 %) and 93 % (range, 85-97%) respectively. Sensitivity decreased with increased number of aneurysm clips ($p = 0.045$) and decreased remnant size ($p = 0.02$). Also, sensitivity correlated with artifact ($p = 0.002$) and certainty scores ($p = 0.006$).

CONCLUSION

The overall sensitivity of CT angiography to detect residual aneurysm after aneurysm clipping is low (48 %). Sensitivity improves with fewer clips, larger remnant size, lower artifact scores and higher certainty scores. Average specificity was relatively high (93%) suggesting that when an aneurysm remnant is described on CTA, it is unlikely to be a false positive. In this context, it may be reasonable to screen patients after single aneurysm clipping with CTA to exclude significant residual. If present and identifiable on CTA, it would be reasonable to follow the residual with CTA. Aneurysm clip metallurgy also affects the degree of artifact created and requires further investigation.

KEY WORDS: CT angiography, aneurysm, postclip residual

Paper 153 Starting at 4:20 PM, Ending at 4:28 PM

Arteriographic Demonstration of Slow Antegrade Opacification Distal to a Cerebrovascular Thromboembolic Occlusion Site as a Favorable Indicator for Intraarterial Thrombolysis

Christoforidis, G. A. • Slivka, A. • Mohammad, Y. • Tejada, A. • Slone, H. W. • Bourekas, E. • Chakeres, D.

The Ohio State University
Columbus, OH

PURPOSE

To determine whether slow antegrade contrast opacification of an occluded cerebral artery distal to thrombus (clot outline sign) on cerebral arteriograms performed immediately prior to thrombolytic treatment is associated with higher recanalization rates relative to patients without antegrade contrast opacification distal to the the occlusion site.

MATERIALS & METHODS

This study retrospectively reviewed the records and available images from 74 consecutive arteriograms performed prior to thrombolysis in patients eligible for intraarterial thrombolysis where the microcatheter was able to reach the occlusion site. The arteriograms were reviewed to identify whether contrast filled the occluded vessel distal to the occlusion site on the delayed images. Patients were not included if the arteriograms were not available for review. This was correlated then to the recanalization rate and TIMI score using contingency analysis. Logistic regression analysis for recanalization was performed which included presence of outline sign, age, time to treatment, sex, and admitting glucose value.

RESULTS

Sixty-eight of the original 74 arteriograms were available for review. Eighteen patients were identified who displayed the clot outline sign. Thirteen (72%) went on to completely recanalize whereas four went on to partially recanalize, and only one (5.6%) did not recanalize. Sixteen (32%) of 50 patients without demonstration of contrast opacification distal to the occlusion site went on to recanalize, 19 (38%) went on to partially recanalize, and 15 (30%) did not recanalize ($p = 0.0068$). Seventeen of 18 patients (94.4%) displaying the clot outline sign were associated with a TIMI score of 2 or 3 whereas only 31 (62%) of those without the clot outline sign were associated with TIMI scores of 2 or greater ($p =$

0.0041). Logistic regression analysis for recanalization relative to other predictors indicates that only the clot outline sign could act as a predictor for recanalization ($p = 0.0097$).

CONCLUSION

Prethrombolysis arteriograms demonstrating delayed antegrade contrast opacification distal to the occlusion site is associated with higher recanalization rates.

KEY WORDS: Thrombolysis, stroke, angiography

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of an recombinant tissue plasminogen activator made by Genentech for intraarterial thrombolysis.

Paper 154 Starting at 4:28 PM, Ending at 4:33 PM

Cerebral and Spinal Cavernous Angiomatosis: A Case Report

Ervine, S. L. M. • Wallace, E. W. • Kim, J. K.

Oakwood Hospital
Dearborn, MI

PURPOSE

While cavernous angiomatosis has been well characterized, only a few cases have demonstrated innumerable lesions throughout the entire neural axis. We describe a remarkable case of cerebral and spinal cavernous angiomatosis and review the disease characteristics and imaging findings.

MATERIALS & METHODS

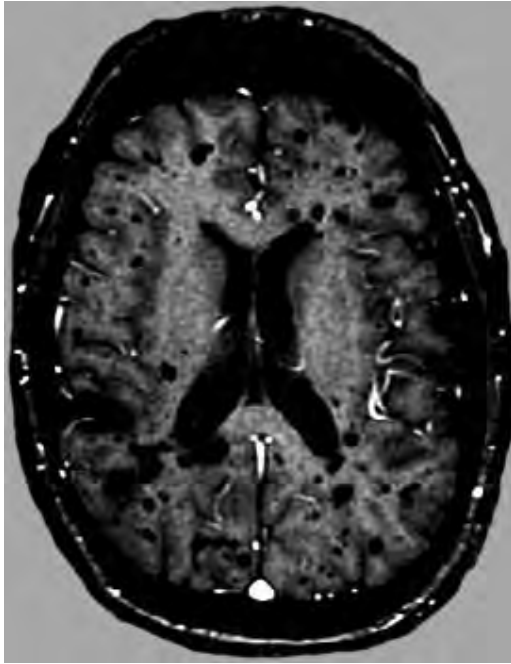
While camping in northern Michigan, a fifty-five-year-old male experienced slurred speech, confusion, dizziness, and balance problems. He presented to our emergency room with gradual worsening of symptoms. CT of the head showed multiple ill-defined hyperdense foci in the cerebrum and cerebellum. In this previously asymptomatic patient, possible diagnoses included metastases, hemorrhagic emboli, infectious vasculitis, or hypertensive angiopathy. Subsequent MR imaging revealed innumerable foci of tiny hemorrhages in differing stages of evolution. Several hemorrhagic foci appeared recent. While the diagnosis of cavernous angiomatosis was easily recognizable with routine spin echo (SE) sequences, gradient recalled echo (GRE) imaging showed a dramatic four-fold increase in lesion density throughout the brain and spine, totaling in the hundreds. To our knowledge, only one case of more than one hundred cavernous malformations involving the cerebrum, cerebellum, brain stem, and spinal cord has been reported (1).

RESULTS

Cavernous malformations are common, occurring in 0.4-0.8% of the general population (1). Four types of cavernous malformations have been described, based on MR imaging characteristics and pathologic correlations (see table) (2). In this case, hundreds of additional Type IV lesions were detected with GRE imaging, and lesions identified with SE imaging were better characterized. Evaluation with GRE imaging provided better characterization of this patient's disease and estimation of his future risk, as risk of future hemorrhage has been correlated with lesion number and location (2).

MR Classification for Cavernous Malformation
(according to Zabramski et al)

Lesion Type	MR Signal Characteristics	Pathologic Characteristics
Type I	T1: hyperintense core	Subacute hemorrhage
	T2: hyper or hypointense core with hypointense rim	
Type II	T1: heterogenous signal	Hemorrhage and thrombosis of varying age
	T2: heterogeneous signal with hypointense rim	
Type III	T1: iso- or hypointense	Chronic hemorrhage
	T2: hypointense with hypointense rim	
Type IV	T1: not seen	Tiny cavernous angiomas or telangiectasias
	T2: not seen	
	GRE: punctate hypointense lesions	



CONCLUSION

GRE imaging is necessary for accurate initial assessment and subsequent follow-up of lesion number and location in cavernous angiomatosis, and for screening of at-risk family members (2). Complete evaluation also must include imaging of the spine.

REFERENCES

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2. Zabramski J, Wascher T, Spetzler R, Johnson B, Golfinos J, Drayer B, et al. **The Natural History of Familial Cavernous Malformations: Results of an Ongoing Study.** *J Neurosurg* 1994;80:422-432

KEY WORDS: Cavernous malformations, cavernous angiomatosis, cerebral vascular malformations

Tuesday Afternoon

3:00 PM - 4:30 PM

Ballroom 6 A

**(29b) Adult Brain: Functional Imaging
(fMRI, MSI, MRS, PET)
(Scientific Papers 155 - 166)**

See also Parallel Sessions

(29a) Adult Brain: Vascular Imaging

*(29c) Adult Brain: New Techniques,
Postprocessing/Trauma*

(29d) Pediatrics: General

Moderators: Brian C. Bowen, MD, PhD
Michael H. Lev, MD

Paper 155 Starting at 3:00 PM, Ending at 3:08 PM **Molecular Imaging and Neuroradiology**

Dawid Schellingerhout, MD

PRESENTATION SUMMARY

Molecular imaging is the study of molecular events in living organisms by means of imaging. The innovations in this growing field has significant implications for the future practice of neuroradiology. Basic molecular imaging contrast mechanisms will be discussed, with examples of each. The emerging modalities of molecular imaging will be reviewed, together with examples of applications in biomedical research. The role of molecular probes and contrast agents will be discussed, including activatable agents. The current limitations and potential future developments in molecular imaging will be discussed, with emphasis on those developments of interest to neuroradiologists.

This paper was selected to receive the Norman Leeds Best Paper Award by the Eastern Neuroradiological Society (ENRS) at its 15th Annual Meeting held in August, 2003.

Paper 156 Starting at 3:08 PM, Ending at 3:16 PM**Intrasubject Reliability of Functional MR Imaging Mapping of Frontal and Temporal Language Areas**

Davidson, K. • Moritz, C. • Rowley, H. • Haughton, V.

University of Wisconsin
Madison, WI**PURPOSE**

For preoperative functional MR imaging (fMRI) mapping, reproducibility of language tasks must be known. We tested the hypotheses that reproducibility for language tasks depends significantly on the area of language cortex and the choice of task.

MATERIALS & METHODS

Seventeen patients who performed letter-word generation (LWG), antonym-word generation (AWG), and text reading (TR) tasks were analyzed. Within frontal and temporal language regions activated voxels were counted and laterality indices were calculated. Regional concurrence ratios (number of activated voxels common to two tasks/mean of total voxel counts from both tasks) were calculated for each task pair. Concurrence ratios were compared for tasks with components of language expression (LWG, AWG) and language comprehension (AWG, TR).

RESULTS

The 3 tasks consistently produced activation in anterior and posterior language regions. Laterality indices correlated positively for the LWG and AWG tasks in the anterior language region, and for the TR and AWG tasks posteriorly. In the left anterior language region, the mean concurrence ratio was 46% for the LWG/AWG task pair, and significantly ($p < 0.05$, Student's t test) lower for other pairs. In the posterior language region, the mean concurrence ratio was 45% for AWG/TR, and lower for other task pairs. In patients with right hemispheric dominance, concurrence ratios in the right hemisphere approximated those in the left hemisphere.



Figure 1. Concurrent activity in the right hemisphere between AWG and TR tasks in a patient with a left frontotemporal tumor.

CONCLUSION

The LWG/AWG task pair has the highest concurrence ratio in the frontal language area and the AWG/TR task pair has the highest concurrence ratio in the temporal language area. Performance of multiple language tasks may facilitate mapping of anterior and posterior language regions.

KEY WORDS: fMRI, language, mapping

Paper 157 Starting at 3:16 PM, Ending at 3:24 PM**Practical Visual Integration of Multifunctional Brain Tumor Images**Jensen, T. R.^{1,2} • Schmainda, K. M.¹ • Ulmer, J. L.¹ • DeYoe, E.¹ • Prost, R. W.¹¹Medical College of Wisconsin, Milwaukee, WI, ²Marquette University, Milwaukee, WI**PURPOSE**

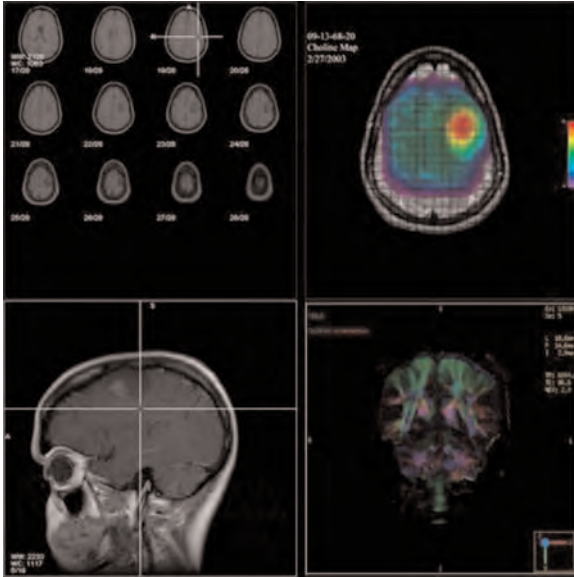
The goal of this project is to create interactive clinician software that will facilitate the diagnosis and treatment planning of brain tumors using multiple physiologic MR imaging parameters. Techniques such as functional MR imaging (fMRI) used to locate sensory, motor, visual, and language cortex, MR spectroscopy (MRS) used to provide metabolite maps, relative cerebral blood volume imaging (rCBV) used to identify neovascularity, and diffusion tensor imaging (DTI) used to identify critical white matter tracts are becoming available on a widespread basis and are gaining acceptance as clinical tools. Each technique typically requires its own specialized software tools, which are meant usually for research purposes and not streamlined for clinical use. In addition, there is no readily available software to analyze and visualize the output from all techniques on one display. Yet, the integration of physiologic MR imaging data may provide superior clinical information for these patients. This exhibit illustrates the first step taken towards the goal of providing physicians with a streamlined and efficient means to make clinical decisions using information available from each and all of the imaging techniques, while optimizing the understanding of critical spatial relationships. It shows how software can be developed to integrate the various postprocessing and visualization methods of multiple physiologic MR imaging parameters on a single workstation and display device.

MATERIALS & METHODS

Three or four physiologic MR imaging data sets including fMRI, DTI, 2D chemical shift MRS, and rCBV were acquired in 25 patients with brain tumors or other resectable brain lesions. A detailed radiologic analysis of each patient was carried out to determine key issues in spatial localization and information gathering around each physiologic parameter. The relationships of resectable lesions to physiologic maps and among physiologic parameters were considered of prime importance. From this analysis, an interactive physician interface visual display was designed. A high level system design of integrated physiologic imaging software for brain tumor patients was created and targeted for workstations using Windows® (Microsoft Corporation). Software input included postprocessed images derived from the above data sets in various file formats.

RESULTS

The prototype software built allows clinical users (neuro-radiologists, neurosurgeons, radiation oncologists) to examine multiple image data sets generated from the techniques described above, at the same time and on the same display (sample screenshot below). Each image data set can be displayed over anatomical images of the users choosing, separately or simultaneously. The display tool was judged extremely useful by clinical end users and to be vastly superior to existing imaging strategies.



CONCLUSION

The interactive physician imaging interface prototype demonstrated its usefulness in displaying and integrating multiple physiologic parameters. Physicians found the tool to be extremely useful and efficient in establishing spatial relationships.

KEY WORDS: Visualization, neoplasms, postprocessing

Paper 158 Starting at 3:24 PM, Ending at 3:32 PM

Patterns of Brain Activation during Encoding and Recognition of Verbal and Figural Information in Older Adults

Kraut, M. A.¹ • Beason-Held, L.² • Golski, S.² • Esposito, G.³ • Resnick, S. M.²

¹The Johns Hopkins Medical Institutions, Baltimore, MD,

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³Laboratory of Personality and Cognition, National Institute on Aging, National Institutes of Health, Bethesda, MD

PURPOSE

In the cognitive neurosciences, investigators have proposed several models to help predict patterns of brain activation during memory encoding and retrieval. One of these, the hemispheric encoding/retrieval asymmetry (HERA) model, postulates that the prefrontal regions in the left hemisphere are more active during memory encoding, while the right is more active during retrieval. The hemispheric asymmetry reduction in older adults (HAROLD) model suggests that activity in older brains tends to be less lateralized than that

in younger subjects. Our goal was to examine, in older adults, patterns of brain activation during both encoding and retrieval phases of verbal and visuospatial memory tasks.

MATERIALS & METHODS

Using H₂¹⁵O PET to estimate regional changes in cerebral blood flow, we tested 11 normal right-handed adults (6F, mean age = 71.1 years) on tasks that involved both encoding and retrieval of words and figures. The words and figures were chosen to reduce the likelihood of using visualization strategies to remember the words, or verbal strategies to remember the shapes. Modality-specific stimulus-matching tasks ("are these simultaneously presented stimuli the same or different?") were used to control for simple visual perception and motor movement-related CBF changes.

RESULTS

Compared to the verbal matching task, verbal encoding was associated with increased rCBF in both frontal regions, left more extensive than right, the left anterior cingulate, and left>right temporal lobes. Figural encoding was associated with increases in rCBF in both frontal and temporal lobes. During verbal retrieval, there were rCBF increases in the left frontal and right temporal regions. Figural recognition resulted in bilateral increases in frontal rCBF. During encoding, there were common regions of rCBF increases across tasks, all in the left hemisphere, mostly frontal. Two regions (cuneus, bilaterally) showed more activity with verbal than with figural encoding. Several regions showed greater activity with figural encoding than with verbal: right mesial temporal, occipitotemporal and cuneus, and left cuneus. With retrieval, the insulae and middle temporal gyri were similarly activated across tasks, while greater left inferior frontal rCBF activity was evident during the verbal retrieval phase compared to figural. With figural retrieval, there was more change in rCBF in the right inferior temporal lobe than there was during verbal retrieval. Evaluation of task-related rCBF asymmetries shows that verbal encoding, compared to recognition, results mostly in left hemisphere activation, while the converse comparison shows a greater representation of rCBF change in both hemispheres. With figural encoding compared to retrieval, there is also a predominance of left-sided activation, while with retrieval, rCBF increases are more bilateral. Region-of-interest analyses in prefrontal regions showed no task-wise or phase-wise difference in BA 10, but significant right>left differences for both tasks in BA 46.

CONCLUSION

Our data overall weakly support the HERA model, but not the HAROLD model, given the relative preservation of lateralization of task-related rCBF changes. The symmetric BA10 rCBF changes, and the right>left asymmetries in BA46, however, run counter to these generalizations, and may reflect regionally specific functional reorganization, increased variability in regional activity, or a combination.

KEY WORDS: Memory, aging, functional imaging

Paper 159 Starting at 3:32 PM, Ending at 3:40 PM

Imagining a Tune: Discrimination of Lyrical and Nonlyrical Musical Imagery with Functional MR Imaging

Flanders, A. E. A. • Tracy, J. I. • Enochs, W. S. • Lai, S. • Goyal, N. • Laskas, J. • Madi, S. • Waldron, B.

Thomas Jefferson University Hospital
Philadelphia, PA

PURPOSE

The processing of musical stimuli is known to invoke activation of the superior temporal gyrus bilaterally as well as portions of the parietal lobe. The process of memorization or recall of music (musical imagery) is less well understood. Visual imagery data suggest that the nondominant posterior parietal cortex is crucial to such imaginal activity, though studies also indicate that the striate cortex is recruited. Much less is known about the substrates of auditory imagery. The purpose of this investigation is to identify the areas of the brain that are activated specifically during the process of imagining a tune and to demonstrate distinct differences in cortical activity between recall of nonlyrical and lyrical music.

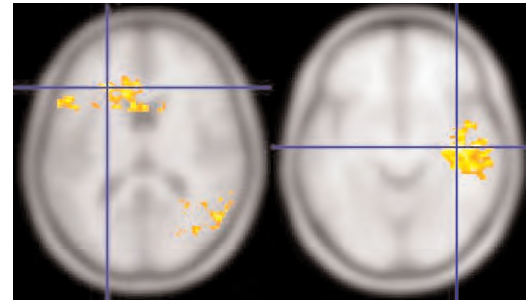
MATERIALS & METHODS

Eighteen normal volunteers were scanned on a 1.5 T system using a standard head coil. A MR compatible sound system with stereophonic headphones was used. Imaging consisted of a single gradient-echo echo-planar acquisition (TR 4 sec, TE = 54, 1.9 x 1.9 x 5 mm, 128 x 128 matrix) of 26 axial images for whole brain coverage. In a blocked design (randomized, counterbalanced), subjects were asked to imagine familiar lyrical or nonlyrical songs after being given a 3 second cue (tape) of the actual song. Separate blocks were devoted to listening to comparable lyrical and nonlyrical songs. Control conditions were administered, with covert speech serving as the chief control for the imagery conditions. A total of 142 time points were collected. Statistical parametric maps (SPM '99) were produced comparing the imagery conditions (lyrical, nonlyrical) to covert speech and rest.

RESULTS

Activation data for lyrical and nonlyrical conditions are shown in Table 1. The comparison to covert speech revealed left inferior frontal (Figure 1a) and right insula/temporal (Figure 1b) regions of activation. A large region of anterior cingulate activation characterized the activation associated with the nonlyrical songs.

Activation Associated with Lyrical & Non-Lyrical Imagery							
Experimental Condition	Comparison Condition	Cluster-level (P corrected)	Cluster level k _E	Maxima Z	Talairach Coordinate {x,y,z}mm	Brain Region	Brodman Area
Lyrical	Rest	.000	5810	3.08	-45, 30, 26	Left Middle Frontal	46, 9
	Covert Speech	.000	1200	3.09	39, -15, 8	Right Insula, Temporal Gyrus	n/a
		.052	477	2.92	-24, 30, 8	Left Inferior Frontal	46
Non-Lyrical	Rest	.000	1840	3.06	9, 24, 31	Right Cingulate Gyrus	32
	Covert Speech	.000	1964	4.22	9, 0, 37	Right Cingulate Gyrus	32, 24
	Listening	.000	1016	3.71	4, 12, 36	Right Cingulate Gyrus	32
		.036	151	3.54	47, 20, -18	Right Superior Temporal Gyrus	38



CONCLUSION

Distinctly different areas of the brain are recruited for imagery of lyrical and nonlyrical passages; words provide the verbal scaffolding to access lyrical songs as reflected in the left frontal activation. Nonverbal aspects of the imagery (melody, rhythm) are accessed through right temporal structures. In contrast, the regions associated with the nonlyrical songs (anterior cingulate) appear less reflective of these specific processes and are indicative of the increased demand on attentional resources that emerges when verbal cues are not available. This suggests that the nonlyrical songs were harder to imagine.

REFERENCES

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KEY WORDS: Functional MR imaging, musical imagery, cognition

Paper 160 Starting at 3:40 PM, Ending at 3:48 PM

Functional MR Imaging Evaluation of Brain Activation during Deep Brain Stimulation for Treatment of Parkinson's Disease

Phillips, M. D. • Baker, K. B. • Lowe, M. J. • Tkach, J. A. • Cooper, S. • Kopell, B. • Rezai, A. R.

Cleveland Clinic Foundation
Cleveland, OH

PURPOSE

To study the pattern of activation produced by deep brain stimulation (DBS) electrode stimulation in the STN using functional MR Imaging (fMRI).

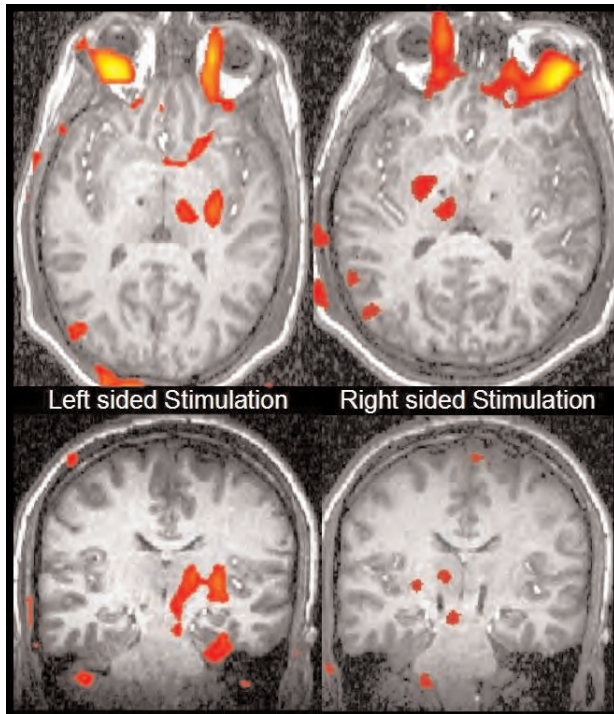
MATERIALS & METHODS

Four patients with percutaneously extended bilateral DBS electrodes in the STN for the treatment of Parkinson's disease (PD) were studied using a 3 T Siemens Allegra MRI (Erlangen, Germany) on the first or second postoperative day. The externalized lead system was extended through the waveguide to an external pulse generator in the MR control room. Optimal stimulation for alleviation of symptoms was determined by extensive testing prior to imaging. Scanning consisted of: 1) three-dimensional anatomical data set with leads disconnected from the pulse generator and 2) gradient-echo EPI BOLD fMRI with a single lead connected to the pulse generator. BOLD images were acquired using prospective motion correction. Functional MR imaging examinations were performed with a block style paradigm consisting of 5 stimulator off and 4 stimulator on 32 second epochs with 10 seconds placed between the stimulator off and stimulator on conditions in order to gradually ramp the stimula-

tor to the optimal stimulation level. Gradual ramping was employed for patient comfort and to decrease patient motion. Images acquired during the ramping process were discarded prior to image analysis. All data were filtered spatially with a Hamming filter that increased BOLD contrast to noise. The MR imaging time series at each pixel was fit using least squares to a boxcar reference function plus a slope and intercept.

RESULTS

All four subjects completed the study with activation demonstrated from 6 of the 7 electrodes stimulated. In all cases activation was demonstrated in the anterior thalamus and posterior portions of the globus pallidus and putamen. Four of the electrode stimulations demonstrated additional activation in the subthalamic nucleus/substantia nigra (SN) region adjacent to the electrode tip. For two electrode stimulations activation was seen in the contralateral superior cerebellum. Typical activation results are displayed in Figure 1. Activation was identified consistently in the ipsilateral posterior globus pallidus, posterior putamen, and thalamus. Jech et al. demonstrated this pattern at 1.5 T in two out of four of their subjects (1). Additionally, activation was seen in the ipsilateral STN/SN region and contralateral cerebellum. Areas of activation noted by Jech et al. in the dorsal lateral prefrontal cortex, superior colliculus, and contralateral caudate nucleus were not seen (1). Importantly, the present study demonstrates activation only ipsilateral to stimulating electrode suggesting that artifact secondary susceptibility effects is unlikely to explain the activation results.



CONCLUSION

Stimulation of therapeutically effective contacts of a DBS electrode in the STN produces a consistent pattern of ipsilateral activation deep brain motor structures.

REFERENCES

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KEY WORDS: Functional MR imaging, deep brain stimulation, Parkinson's disease

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of DBS leads (Model 3387-40), extensions (Model 7495-51), and IPGs (Model 7426) made by Medtronic, Inc. for 3 T functional MR imaging.

Paper 161 Starting at 3:48 PM, Ending at 3:56 PM

Functional MR Imaging Using a Gadolinium-Based Long Intravenous Half-Life Contrast Agent at 1.5 T

Morton, D. W. • Keogh, B. P. • Lim, K. • Maravilla, K. R.

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Seattle, WA

PURPOSE

Functional MR imaging (fMRI) has gained widespread use in neuroscience research and clinical medicine. Mandeville et al. demonstrated a cerebral blood volume (CBV) weighted fMRI technique using an intravenous iron-based blood pool contrast agent, MION, with a T2*-weighted imaging sequence (1). We sought to determine the feasibility of developing a similar fMRI technique using a gadolinium-based blood pool contrast agent (MS-325, EPIX Medical) (2).

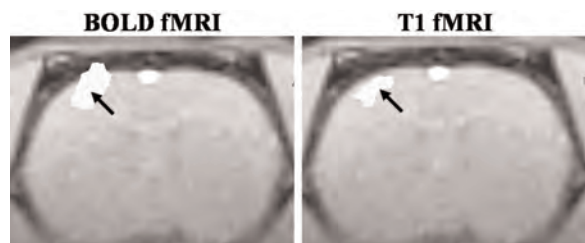
MATERIALS & METHODS

We used a well characterized rat fMRI preparation (3). Anesthetized, adult, male Sprague-Dawley Rats were maintained on a ventilator with careful monitoring and regulation of vital signs and blood gases. Sensory cortex was imaged using a custom-built head coil on a 1.5 T scanner. During forepaw electrical stimulation, gadolinium-based functional MR imaging measurements were performed using a T1-weighted 3D GRE sequence (TE = 2.1s, NEX = 1, FLIP = 25, FOV = 12 x 12 cm, matrix = 128 x 128, 1.1 mm slice thickness, 8 slice locations with 31 volume acquisitions per fMRI measurement) in 14 different animals (10 test animals and 4 controls). In each animal, a BOLD fMRI measurement was performed first. Then, either 0.1 mM/kg of MS-325 (test animals) or an equivalent volume of normal saline (control animals) was administered intravenously and a T1 fMRI measurement was performed. Activations were identified with a standard correlation analysis using MEDx (Sensor Systems, Sterling, VA).

RESULTS

In all 10 test animals, both the BOLD and T1 fMRI measurements demonstrated a cluster of activated voxels in the expected location of the forepaw sensory cortex contralateral to the stimulated forepaw. The location of the most significantly active voxel in the BOLD and T1 functional measurements were not significantly different. The control animals (i.e., IV saline instead of MS-325) showed robust BOLD activations, but no T1 functional activations. The attached image shows BOLD and T1 functional MR activa-

tion maps from the same animal. The arrows indicate the most significantly active voxel in each measurement. High signal in the superior sagittal sinus is related to circulating gadolinium contrast enhancement and does not represent functional activation.



CONCLUSION

We have demonstrated a functional MR imaging technique based on a long intravenous half-life gadolinium contrast agent (MS-325) using a T1-weighted pulse sequence. This technique has the potential for allowing functional imaging while minimizing the susceptibility-related artifacts associated with BOLD functional MR techniques.

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3. Morton DW, Maravilla KR, Meno JR, Winn HR. **Clinically Relevant Rat Model for Testing BOLD Functional MR Imaging Techniques Using Single-Shot Echo-Planar Imaging at 1.5T.** *Radiology* 2001;218:598-601

KEY WORDS: Functional imaging, rat sensory cortex, EPIX (MS-325)

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of MS-325 made by EPIX Medical for Functional MR Imaging.

The authors of this work have indicated the following affiliations/disclosures: EPIX Medical: Previous research grant.

Paper 162 Starting at 3:56 PM, Ending at 4:04 PM

Perfusion MR Imaging of Brain Arteriovenous Malformation Using Factor Analysis

Ducreux, D. F.¹ • Buvat, I.² • Mikulis, D.³ • ter Brugge, K.³ • Bittoun, J.¹ • Lasjaunias, P.¹

¹CHU de Bicetre, Le Kremlin-Bicetre, FRANCE, ²U⁹4, Paris, FRANCE, ³Toronto Western Hospital, Toronto, ON, CANADA

PURPOSE

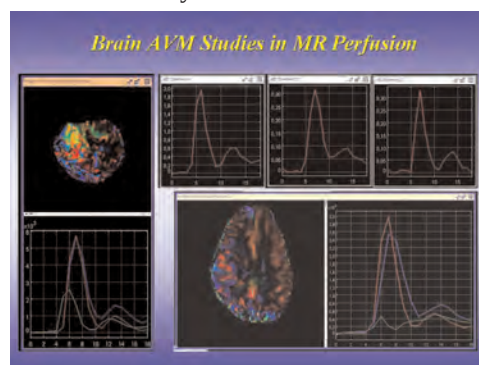
To evaluate MR perfusion disturbances induced by brain arteriovenous malformations using both indicator dilution theory and factor analysis.

MATERIALS & METHODS

Forty patients and 10 volunteers underwent brain MR perfusion gradient-echo sequences using a 1.5 T MR scanner with gadolinium-chelate injection. Perfusion data were processed quantitatively using indicator dilution and factor analysis algorithms to create maps of cerebral blood volume (CBV) and cerebral blood flow (CBF), of which regions of interest were computed in gray and white matter areas. Results were evaluated using correlation coefficients and a specific method called "No Gold Standard evaluation method."

RESULTS

On the 40 patients, all had hemodynamic disturbances around the AVM nidus such as hyperperfused areas (CBF = 300 +/- 150 ml/min/100 g in gray matter), hypoperfused areas (CBF = 30 +/- 15 ml/min/100 g in gray matter) and venous congestion areas (CBF = 60 +/- 20 ml/min/100 g and CBV = 8 +/- 2 ml/100 g in gray matter), but only 7 had remote disturbances of venous congestion and hypoperfused areas in both white and gray matter. These areas were revealed using the Factor Analysis method and not seen using the regular indicator dilution theory method.



CONCLUSION

Factor Analysis is a useful method to reveal areas of abnormal brain perfusion which were not seen using regular dilution indicator theory.

KEY WORDS: Brain AVM, perfusion MR imaging, factor analysis

Paper 163 Starting at 4:04 PM, Ending at 4:12 PM

High-Resolution Diffusion Imaging in Areas of Magnetic Susceptibility Difference: Parallel Imaging and PROPELLER

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²University Health Network, Toronto, ON, CANADA

PURPOSE

Diffusion-weighted imaging (DWI) represents a critical advance in the neuroimaging of acute stroke and other pathologies. On the other hand, sensitivity to water microscopic motion brings with it extreme sensitivity to bulk patient motion. Consequently, most implementations of diffusion-weighted imaging rely on single-shot echo-planar imaging acquisitions, typically characterized by low spatial resolution, geometric distortion, and magnetic susceptibility artifact associated with the long echo time, TE. This study evaluates the role of parallel imaging (to reduce echo train

length and TE) as well as multishot radial fast spin-echo diffusion-weighted imaging (PROPELLER) for diffusion-weighted imaging in regions of magnetic susceptibility difference, namely the base of the brain.

MATERIALS & METHODS

Ten healthy volunteers and 16 neurologic patients were examined with diffusion-weighted EPI (TE = 69 ms), diffusion-weighted EPI (with parallel imaging, ASSET) (TE = 59 ms), high-resolution (256 matrix) diffusion-weighted EPI with ASSET (TE = 65 ms) and PROPELLER diffusion-weighted imaging. All scans were performed using Excite high speed receivers (up to 250kHz bandwidth) using an 8-element head coil (MRI Devices Corp.) on a 1.5 T TwinSpeed magnet (General Electric Medical Systems) with diffusion sensitivity “b-values” of 0 and 1000 s/mm².

RESULTS

In all healthy volunteers, use of ASSET improved image sharpness (gray/white contrast) and reduced susceptibility artifact near tissue:air and bone:air interfaces (see Figure). Increasing matrix resolution from 128 to 256 incurred only a 5 ms TE penalty yet yielded single shot T2 and diffusion-weighted echo planar images of submillimeter resolution. Use of PROPELLER FSE diffusion-weighted imaging improved visualization of anatomical structures near susceptibility differences, but at the expense of scan time. In 3/16 neurologic patients, PROPELLER scans were of subdiagnostic quality attributable to patient motion; on the other hand, in one postsurgical patient with a metal staple in the scalp, diffusion-weighted EPI was nondiagnostic, whereas PROPELLER imaging allowed tissue resolution.

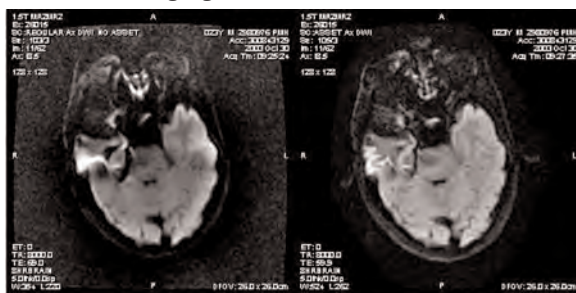


Figure. (left) Diffusion-weighted EPI incurs significant magnetic susceptibility-related signal mismapping and voiding; use of ASSET (right) reduces this effect, while improving overall image sharpness.

CONCLUSION

The combination of parallel imaging with high resolution EPI scanning allows submillimeter resolution in a single shot, markedly improving the conspicuity of embolic lesions. PROPELLER scanning is almost entirely insensitive to magnetic susceptibility artifact but remains at least somewhat sensitive to motion. High-resolution single-shot EPI is an attractive option for T2 screening of an uncooperative patient and for high anatomical resolution diffusion-weighted imaging in the setting of multiple embolic lesions. PROPELLER is indicated in studies associated with limiting magnetic susceptibility artifact as commonly encountered after prior surgery.

The authors of this work have indicated the following affiliations/disclosures: General Electric Medical Systems: Research support.

KEY WORDS: Diffusion, susceptibility

Paper 164 Starting at 4:12 PM, Ending at 4:20 PM

MR Spectroscopy in the Differentiation of Recurrent Neoplasm from Tumor Necrosis in Recurrent Intracranial Contrast Enhancing Lesions

Weybright, P. N. • Maly, P. V. • Gomez-Hassan, D. • Nan, B. • Sundgren, P. C.

University of Michigan Medical Center
Ann Arbor, MI

PURPOSE

Recurrent contrast-enhancing lesions in previously identified intracranial neoplasms that have undergone treatment with chemotherapy and/or radiation therapy can pose a diagnostic dilemma. They may represent recurrent tumor or necrosis/inflammation from radiation and chemotherapy. Imaging characteristics alone do not often enable discrimination of these two entities and intracranial biopsy carries significant morbidity. Symptomatology and clinical course are often left to determine if a neoplasm has recurred. Earlier identification of recurrent intracranial neoplasms would afford the opportunity to begin adjunctive therapy as soon as an imaging abnormality is detected.

MATERIALS & METHODS

MR spectroscopy (MRS) was performed on 27 patients (aged 4-61 years, mean 35 years) with newly found contrast-enhancing lesions at the site of a previously diagnosed brain neoplasm subsequently treated with radiation and chemotherapy. Seven lesions were located in the posterior fossa or brainstem, a region in which two-dimensional chemical shift imaging (2D CSI) has traditionally proven challenging. In addition to conventional MR imaging, multivoxel (2D CSI) (PRESS, TE/TR 144/1000 msec, FOV 16 x 16, thickness 10-20 mm) spectroscopy was performed in 25 patients, including 6 patients with posterior fossa or brainstem lesions. Single voxel spectroscopy (SVS) was necessary in 2 patients (PRESS, TE/TR 144/1500 msec, FOV 24, thickness 20 mm). Patients were followed from 8-28 months and had subsequent imaging; in several cases brain biopsy, and clinical follow-up. Follow-up data and outcomes were used as surrogates of a lesion's original identity as tumor recurrence or not.

RESULTS

Choline (Cho), creatine (Cr), lactate, and N-acetylaspartate (NAA) peaks were resolved easily and readily quantifiable on 2D CSI. Fourteen patients had lesions identified as recurrent neoplasm based on clinical and imaging follow-up and in several cases biopsy. Thirteen patients had lesions identified as tumor necrosis/inflammatory treatment-related change, also based on follow-up data. Average and mean Cho/Cr, NAA/Cr, and Cho/NAA ratios were calculated for each group. All ratios were statistically significantly different comparing treatment-related change from normal adjacent white matter ($p < 0.0001$, $p = 0.002$, and $p < 0.0001$, respectively). All ratios were also statistically significantly different comparing tumor recurrence from radiation change ($p < 0.0001$, $p = 0.003$, and $p < 0.0001$, respectively). Cho/Cr ratio averages were 1.02 (range 0.86-1.39) for normal white matter, 1.56 (range 1.22-1.76) for treatment related change, and 2.30 (range 1.65-3.24) for recurrent tumor. Cho/NAA ratios were 0.79 (range 0.57-1.23) for normal white matter, 1.46 (range 1.04-2.18) for treatment-related change, and 3.10 (range 1.70-6.47) for recurrent tumor.

CONCLUSION

MR spectroscopy and in most cases 2D CSI, with quantifiable metabolite peaks can be obtained in the evaluation of recurrent contrast-enhancing lesions at the site of a treated intracranial neoplasm, including posterior fossa and brainstem lesions. While overlap in both Cho/Cr and Cho/NAA ratios does exist between the recurrent tumor and treatment-related change populations, metabolite ratios for these groups are statistically significantly different. Overlap may be related to histologic heterogeneity or volume averaging of normal and abnormal tissues. MR spectroscopic differences in conjunction with conventional imaging may enable discrimination of recurrent neoplasm from treatment-related change when a recurrent contrast-enhancing lesion is identified initially.

KEY WORDS: MR spectroscopy, neoplasm, tumor necrosis

Paper 165 Starting at 4:20 PM, Ending at 4:25 PM**MR Imaging and MR Spectroscopic Appearance of an Unusual Case of Unilateral Multifocal Cerebral Lymphocytic Vasculitis**

Niku, S. • Imbesi, S. G.

University of California San Diego Medical Center
San Diego, CA

PURPOSE

To describe the MR imaging and spectroscopic findings of an unusual case of multifocal cerebral lymphocytic vasculitis and to demonstrate the utility of MR spectroscopy in the evaluation of tumefactive lesions of the CNS.

MATERIALS & METHODS

A 25-year-old woman presented with seizures, frontal headaches, and left arm and leg weakness. Physical examination and laboratory evaluation were otherwise unremarkable. Using a 1.5 T Siemens Symphony superconducting magnet, brain MR imaging and MR spectroscopy using a PRESS protocol with short (30 msec) and long (144 msec) TE were performed. As definitive diagnostic evidence was required prior to institution of appropriate therapy, a stereotactic biopsy was obtained.

RESULTS

MR imaging demonstrated multiple enhancing lesions throughout the entire right cerebral hemisphere with extensive associated vasogenic edema. These lesions were located predominantly in a peripheral distribution with some involvement of the right basal ganglia structures. The left cerebral hemisphere, cerebellum, and brainstem were spared. MR spectroscopy of the two largest lesions demonstrated marked elevation of the glutamate and glutamine peaks (2.2-2.4 ppm), marked elevation of the lipid peak (0.9-1.2 ppm), mild elevation of the lactate peak (1.3 ppm), mild decrease in the NAA peak (2.0 ppm), and no significant elevation of the choline peak (3.2 ppm). Histologic evaluation revealed extensive evidence of chronic inflammation, lymphocytic vasculitis, necrosis, and infarction without evidence of organisms or malignancy.

CONCLUSION

MR spectroscopy can be very beneficial in the evaluation of tumefactive lesions of the CNS. In the case presented above, MR findings initially were felt to be most compatible with multifocal glioma, especially given the predominant unilateral distribution of disease. However, MR spectroscopy did not reveal elevation of the choline peak which one would typically expect to see with aggressive neoplastic processes. The most striking abnormality noted was the marked elevation of the glutamate and glutamine peaks. This appears to be a finding associated with inflammatory processes of the CNS and typically is not seen with neoplasms. Thus, elevation of the glutamate and glutamine peaks present in tumefactive lesions of the CNS may indicate an etiology other than neoplasm and, in the future, may obviate the need for brain biopsy.

KEY WORDS: MR spectroscopy, lymphocytic vasculitis

Paper 166 Starting at 4:25 PM, Ending at 4:30 PM**Symptomatic Tethered Brain Syndrome in an Adult**

Ulmer, J. L. • Hacein-Bey, L. • Wagner, M. L. • Prost, R. W. • Krouwer, H. G. J. • Meyer, G. A.

Medical College of Wisconsin
Milwaukee, WI

PURPOSE

We present the case of a 58-year-old male with an 18-month history of progressive right hand and fourth and fifth digit spastic paresis. The patient had a long-standing bony protuberance arising from the right parietal cranium. He was recreationally active, frequently barefoot water skiing. The imaging and surgical findings supported the diagnosis of a symptomatic tethered brain syndrome.

MATERIALS & METHODS

CT and MR imaging of the brain and cranium were acquired, focused on the right parietal cranium and adjacent brain convexities. Diffusion tensor imaging (DTI) color-coded directional anisotropy and BOLD fMRI maps were acquired. Functional MR imaging tasks included bilateral tongue and face movement, left and right finger tapping, and left elbow, shoulder, hip and ankle movements. Also, superselective angiography and sodium amytal (WADA) testing of arteries around the motor cortex was performed.

RESULTS

CT revealed a defect of the right parietal cranial inner table with a focal mass causing diploic space expansion and outer table remodeling. Under-hanging edges of the internal table surrounded the defect and diploic space mass, which was contiguous with adjacent brain. MR imaging revealed a small right parietal encephalocele adherent to the under-hanging internal table edges, and contiguous with adjacent abnormal appearing right precentral gyrus. The precentral gyrus was thickened and the central sulcus posterior-superior-medially to the encephalocele was unusually shallow. Functional MR imaging of tongue and lower face movements revealed typical activation within the right lateral precentral gyrus below the encephalocele. Left finger tapping caused right precentral gyrus activation immediately below the encephalocele, and lesser activity superior-posterior-medially to the encephalocele and in ipsilateral homologous

M1 cortex. Left elbow, shoulder, hip and ankle movement caused right precentral gyrus activation superior-posterior-medially to the encephalocele, but exhibited an unusual overlap of somatotopic cortical fields. No activity was seen within the diploic space tissue. Diffusion tensor imaging revealed a large abnormal appearing white matter bundle extending from the encephalocele through the posterior aspect of the right superior longitudinal fasciculus. Diffusion weighted imaging and ADC maps indicated restricted diffusion within the diploic space tissue compared to that of normal brain. Superselective angiography revealed vascular disorganization supplying the diploic space mass and sodium amytal testing confirmed the lack of functional neuronal elements in this region. At surgery, the craniotomy flap and surrounding dura were shown to be adherent to the right precentral gyrus encephalocele, requiring careful dissection to remove the flap. A biopsy revealed glial elements and dysplasia, without evidence for neoplasm. After surgery, the patient showed immediate significant improvement in motor function and was seizure-free.

CONCLUSION

Imaging and surgical findings were consistent with a small right parietal encephalocele, containing trapped disorganized glial elements. Functional MR imaging and DTI suggested motor cortical and white matter reorganization, respectively. The recent (18 month) history of progressive left hand weakness and spasticity seemed, at first glance, contradictory to the presence of a congenital lesion. Based on the imaging findings and the surgical results, it is suggested that tethering of the encephalocele combined with age-related parenchymal involution and a highly active recreational life-style caused symptomatic traction on right precentral gyrus.

KEY WORDS: FMRI, DTI, tethered brain

Paper 167 Starting at 3:00 PM, Ending at 3:08 PM

Vascular Imaging with Phase-Contrast Vastly Undersampled Isotropic Projection Imaging: An Ultrafast Phase-Contrast MR Angiographic Technique

Turk, A. S. • Gu, T. • Mistretta, C. A. • Rowley, H. A. • Turski, P. A. • Haughton, V. M.

University of Wisconsin Madison
Madison, WI

PURPOSE

By means of undersampling and projection reconstruction, speed increases of a factor of 10 - 30 over conventional Cartesian MR imaging may be achieved. With the increased speed, images of the cerebral and cervical vasculature can be obtained with phase contrast in less time than TOF images. Simultaneous acquisition of anatomical detail and velocity measurement is possible with the technique. However, the under sampling hypothetically results in a type of Nyquist artifact. The purpose of this study was to compare the image quality and artifacts in images of the cranial and cervical circulation obtained with the conventional 3D time-of-flight (TOF) techniques and with phase-contrast - vastly undersampled isotropic projection (PC-VIPR) imaging.

MATERIALS & METHODS

Patients referred for imaging with contrast-enhanced MR imaging/MR angiography (MRA) were asked to undergo a PC-VIPR sequence. The sequence is implemented on a 1.5 T scanner (GE Medical Systems, Milwaukee, WI) with a single-receiver head coil so that each VIPR projection was excited 4 times, once with no flow encoding gradient and once with encoding in the x, y, and z directions. The reference and the three flow direction excitation data were reconstructed for the three flow directions. Parameters for the PC-VIPR were 0.63 mm x 0.63 mm x 0.63 mm voxel size compared to 0.86 mm x 0.74 mm x 1.4 mm, TE of 7.5 ms for PC-VIPR vs 2.4 for 3D TOF. The scan time for a 3 slab 3D TOF was 8:30 and for the PC-VIPR was 5:00 minutes. Informed consent from each patient and IRB approval was obtained.

RESULTS

In this study (12 patients enrolled to date), we found the anatomical depiction of the intracranial and extracranial vessels to be similar in VIPR and in the conventional TOF images. Flow signal intensity was equivalent for both techniques in regions of laminar flow. In a few instances focal signal loss due to pathologic stenosis or complex vessel geometry was more pronounced on the PC-VIPR images, but the overall degree of vascular stenosis was demonstrated equally well in each sequence. The geometrical complex artifacts resulting from severely undersampling in projection acquisition did not detract significantly from image quality or interpretation.

Tuesday Afternoon

3:00 PM - 4:30 PM

Room 606 - 609

(29c) Adult Brain: New Techniques,
Postprocessing/Trauma
(Scientific Papers 167 - 177A)

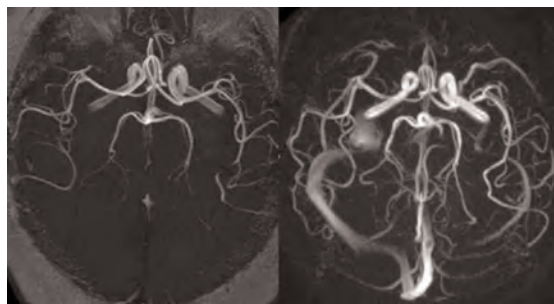
See also Parallel Sessions

(29a) Adult Brain: Vascular Imaging

(29b) Adult Brain: Functional Imaging (fMRI, MSI,
MRS, PET)

(29d) Pediatrics: General

Moderators: Steven G. Imbesi, MD
Aquilla S. Turk, DO



The image on left is a standard 3D TOF and on right is the contrast-enhanced PC-VIPR sequence applied to the same person.

CONCLUSION

The extremely fast PC-VIPR MRA produces images similar in quality as compared to standard 3D TOF images. Further evaluation is warranted to determine the clinical value of the anatomical and physiologic data obtainable by this method.

KEY WORDS: MRA, cerebral vasculature, phase contrast

Paper 168 Starting at 3:08 PM, Ending at 3:16 PM

MR Statistical Mapping of Manganese Transport Disruption and Recovery Following Lesion of the Rat Olfactory Tract

Cross, D. J.¹ • Anzai, Y.¹ • Maravilla, K. R.¹ • Morrow, T. J.² • Flexman, J. A.¹ • Miyoshi, S.¹ • Minoshima, S.¹

¹University of Washington, Seattle, WA, ²Veteran's Administration Hospital, Ann Arbor, MI

PURPOSE

Normal functional connections of the rat olfactory system were mapped statistically in vivo using MR imaging and manganese (Mn) as a transport-mediated transsynaptic tracer. This brain mapping technique was applied to investigate initial disruption and recovery of Mn transport following radiofrequency (RF) lesion of the lateral olfactory tract (LOT).

MATERIALS & METHODS

Six rats were scanned with 1.5 T MR imaging and a rat brain volume coil. 3D SPGR (TE = 6.8 ms; TR = 15 ms; flip angle 45 degrees; 4 NEX) imaging was performed at pre, and 6, 12, 24, 36, and 48, 72 hours (6 rats) and 5.5, 7.5, 10.5, and 13.5 days (3 rats) postadministration of 10 microliter manganese chloride to the right nasal epithelium. Image sets from each rat were coregistered to the same orientation and then registered to the stereotactic atlas (1) (Neurostat software). Global intensity and drift across scans was normalized. Pre and postadministration scans were subtracted in a pair-wise manner and compared statistically across subjects. T statistics were converted to Z maps and superimposed on a template anatomical image. Z score threshold of 4.0 ($p < 0.05$ adjusted for multiple comparisons) was estimated to indicate pixels with significant Mn transport. Region of interest (ROI) analysis used regions identified as statistical peaks. To investigate brain injury and repair, 5 new rats were RF lesioned in the LOT and underwent 3 separate scanning sessions. The first session (scans at pre, and 24, 48, 72 hours post Mn administration) was prior to lesioning. Two other series of scans were obtained at 1 week and 4 weeks postsurgery. Administration, imaging parameters, and analysis were identical to first study.

RESULTS

Most significant changes in cortical intensity were confined to the LOT (70% Z = 15.4) at early time points. At 24 hours postadministration, other structures accumulated enough Mn to show consistent percent change in enhancement across subjects, resulting in cortical peaks outside the LOT and in posterior regions (tubercle 36% Z = 10.1; anterior commissure 30% Z = 6.4; ventral pallidum 26% Z = 5.0; piriform cortex 28% Z = 6.1; amygdaloid piriform transition 15% Z = 5.0). In the lesion study, ipsilateral transport at 1 week postlesion LOT anterior to lesion showed no change (prelesion $60 \pm 22\%$; 1 week postlesion $56 \pm 18\%$), however posterior LOT had significant reduction in transport (pre $41 \pm 20\%$; 1 week $22 \pm 10\%$, $p < 0.05$). After 4 weeks postlesion, recovery of Mn transport in ipsilateral LOT posterior to lesion was seen (pre $41 \pm 20\%$; 4 weeks $36 \pm 21\%$). Additional significant increase in contralateral LOT was seen at 4 weeks (pre $6 \pm 9\%$; 4 weeks $25 \pm 15\%$, $p < 0.01$) associated with greater transport through the anterior commissure.

CONCLUSION

Using statistical brain mapping, Mn transport through the rat olfactory system can be quantified consistently. Radiofrequency lesioning interrupted transport in LOT at 1 week postsurgery. However, recovery of transport posterior to lesion as well as significant contralateral transport indicating possible plasticity to the alternative pathway through commissural fibers were demonstrated at 4 weeks postsurgery. Findings suggest two differential modes of neuronal connectivity reorganization after damage.

REFERENCES

1. Paxinos G, Watson C. **The Rat Brain in Stereotaxic Coordinates.** N Y Acad Press 1998

KEY WORDS: Rat brain, manganese, statistical brain mapping

Paper 169 Starting at 3:16 PM, Ending at 3:24 PM

Dosage Optimization of Ultrasmall Particle Iron Oxide Using a Gradient-Recall Echo Sequence on Ultrahigh MR Field for the Visualization of Rodent Brain Microvasculature

Yang, M. • Christoforidis, G. A. • Figueredo, T. • Abduljalil, A. • Heverhagen, J. • Schmalbrock, P. • Knopp, M.

The Ohio State University
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PURPOSE

To determine whether ultrasmall particle iron oxide (USPIO) intravascular contrast agent can enhance the conspicuity of normal microvasculature in the rodent brain using ultrahigh field high resolution MR imaging and optimize dosage for such imaging.

MATERIALS & METHODS

A total of twelve Wistar rats were divided into 3 groups and anesthetized. The femoral veins were cannulated. Each rodent was imaged before and after intravenous injection of USPIO. Group 1 receive 1 mg/kg, group 2 received 2 mg/kg and group 3 received 3 mg/kg. They were imaged at 8 T on a Bruker AVANCE (Bruker, Billerica, MA) interfaced with

Techron (Crown International, Elkhart, IN) gradient amplifiers and Manex gradients (Magnex Scientific, Abingdon, England) using a custom-built radio frequency front end. A custom made 4 cm diameter birdcage coil was tuned to the head of the rat at 340 MHz while the rat was in the prone position. Imaging sequences included a gradient-recalled echo (GRE) sequence (TR/TE 700/16 msec, flip angle 45°, NEX = 2, 512 x 512 matrix and 78 m m in-plane resolution). All rats recovered from anesthesia after scan. The number of cortical penetrating vessels and the number of deep gray nuclei perforators that could be identified before and after contrast enhancement were counted by two separate reviewers on a section through the level of the caudate nucleus to determine the conspicuity of microvessels. The signal intensity (SI) and signal-to-noise ratio (SNR) on both sides also were measured by a semiautomated method at the same level. Interobserver reliability between two observers on vessel number counts was determined by using student t-test to confirm reproducibility. The change in SI and SNR in all regions of interest (ROIs) were compared before and after contrast administration. Statistical significance was determined using student t-test.

RESULTS

Differences in the number of vessels identified before vs after USPIO administration were statistically significant in all three groups (see Table). The difference between the vessel count at 1 mg/kg and 2 mg/kg was statistically significant ($p = 0.0080$) whereas the difference between 2 mg/kg and 3 mg/kg was not ($p = 0.76$). Reliability for vessel count was confirmed. The SI dropped following USPIO administration by 20.5% in the 3 mg Fe/kg group. This SI drop was lower in the other dosage groups (4.4% in 1 mg Fe/kg and 6.2% in 2 mg Fe/kg), there was no significant difference in SNR before and after contrast administration in each of the three groups.

Table 1: Number of perforating vessels identified at different doses

	Mean number of vessel identified (standard error) at varying doses		
	1mg/kg	2mg/kg	3mg/kg
With USPIO	18.25 (1.66)	31.25 (3.02)	30.00 (2.1)
Without USPIO	9.5 (1.66)	6.75 (3.02)	6.75 (2.1)
P value	0.0107	0.0012	0.0002

CONCLUSION

Postcontrast imaging by intravascular contrast agent USPIO improved the visualization of microvasculature. A dose of 2 mg Fe/kg USPIO appeared to be optimal because it improves visualization of microvasculature at 8 T without sacrificing the SI.

KEY WORDS: Iron oxide, high field MR imaging, microvasculature

Paper 170 Starting at 3:24 PM, Ending at 3:32 PM

Imaging of Microvasculature within the F98 Glioma Model Using Intravascular Contrast Agent on High Resolution Ultrahigh Field MR Imaging with Histopathologic Correlation

Christoforidis, G. A. • Yang, M. • Yang, W. • Barth, R. F. • Chaudhury, A. • Chakeres, D. • Heverhagen, J. • Schmalbrock, P. • Knopp, M.

The Ohio State University
Columbus, OH

PURPOSE

To assess the ability to visualize microvasculature within the F98 rodent glioma model using ultrahigh field high resolution MR imaging aided by the administration of intravascular contrast agent and compare this to histopathology.

MATERIALS & METHODS

High resolution, ultrahigh field (UHF) 8 T MR imaging and ultrasmall particle iron oxide (USPIO) intravascular contrast agent, (SHU555C, Supravist, Schering AG, Berlin) dosage were optimized to define microvasculature in 12 normal male Wistar rats. Tumor cells derived from the F98 undifferentiated glioma cell line were implanted into the right caudate nucleus in 8 Fischer rats. The tumor cells were allowed to grow in vivo until the animal displayed premonitory signs (weight loss, ataxia, and periorbital hemorrhage). At this time the animals were anesthetized and ventilated. They then were imaged at 8 T on a Bruker AVANCE (Bruker, Billerica, MA) interfaced with Techon (Crown International, Elkhart, IN) gradient amplifiers and Manex gradients (Magnex Scientific, Abingdon, England) using a custom-built radio frequency front end. A custom made 4 cm diameter birdcage coil was tuned to the head of the rat at 340 MHz while the rat was in the prone position. Imaging included a gradient-recalled echo (GRE) sequence (TR/TE 700/16 msec, flip angle 45°, NEX = 2, 512 x 512 matrix and 78 m m in-plane resolution) before and after USPIO (2 mg Fe/kg) administration via the femoral vein. Animals were sacrificed immediately after imaging and the brains were removed fixed and sectioned at 1 mm intervals and stained with hematoxylin and eosin and reticulin. The total volume within the tumor which displayed abnormal microvasculature was calculated before and after USPIO administration. Signal loss within the tumor bed also was calculated and compared to the normal hemisphere. Two-tailed student t-test was used to test significant differences. Pathologic specimens were compared to MR images for degree of microvascular density and size of microvessels using semiquantitative methods and compared with contingency analysis.

RESULTS

The volume of visualized abnormal microvasculature increased by an average of 72.2% (std err mean 0.168, $p = 0.0036$) following contrast administration. Comparing pre and postcontrast images the signal intensity within the tumor bearing region dropped by 25.1% (standard error = 3.29%; $p = 0.0001$). Signal loss in the normal side before and after USPIO administration was 7.4% (standard error = 1.22%; $p = 0.0005$). Comparing signal drop within the tumor bearing region to the signal drop in the normal hemisphere, the signal intensity within the tumor bearing region dropped by an average of 9.09% (std err mean = 1.68%; $p = 0.0011$) more

than the signal drop in the normal hemisphere following USPIO administration. Comparing histopathologic specimens to 8 T MR images contingency analysis indicated good correlation for microvascular density ($p = 0.05$) and microvascular size ($p = 0.03$).

CONCLUSION

Ultrasmall particle iron oxide administration significantly enhances the extent of visualization of tumoral microvasculature at 8 T MR imaging with histopathologic confirmation. Signal loss within the tumor bed following administration of intravascular contrast agent also can help quantify abnormal microvasculature. Since the contrast agent used was intravascular this signal loss may act as an indicator of microvascular density.

KEY WORDS: Glioma model, high field MR imaging, microvasculature

Paper 171 Starting at 3:32 PM, Ending at 3:40 PM

Complex Digital Subtraction as a Problem-Solving Tool in Enhanced MR Imaging

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PURPOSE

Enhanced T1-weighted MR imaging of the brain has been used successfully to demonstrate numerous lesions in the brain. Complex subtraction, where the raw data from enhanced images is subtracted from that of unenhanced images, has been shown to be robust with improved images in phantoms and no loss of information on human subjects (1). We propose to illustrate how complex digital subtraction can be used as a problem-solving tool in daily clinical practice.

MATERIALS & METHODS

Over the course of a 6-month period, complex digital subtraction was used in routine clinical cases where enhancement was masked potentially by other findings. Postprocessing was done offline at the MR console (General Electric, Milwaukee, WI) by the technologist. All sequences were reviewed by three neuroradiologists, as part of routine practice.

RESULTS

In all, 24 cases were reviewed with subtracted images. Cases where complex subtraction was used included areas of hemorrhage, postoperative change, sequelae of infection, dural based inflammatory lesions, and calvarial lesions. The utility of subtracted images was most evident where the underlying lesion was masked by hemorrhage. Of equal clinical utility was the demonstration of the absence of a suspected lesion, which was obscured initially by hemorrhage. Enhancement of toxoplasmosis was clarified further. Finally lesions within the skull were more conspicuous. Cases where subtraction was not helpful occurred when motion between the pre and postcontrast images resulted in misregistration.

CONCLUSION

Our study confirms that digital subtraction improves the conspicuity of enhancing brain lesions (2). Furthermore, we have demonstrated that the standard practice of reviewing enhanced images alone may not be sufficient in the clinical setting when hemorrhage is present. Subtle disease may be missed easily when there is initial T1 shortening on unenhanced images. Obtaining and reviewing subtracted images does not add significant time. In using this technique it is vital to check for misregistration artifact, which, if not accounted for, may lead to false interpretation.

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KEY WORDS: Digital subtraction, MR imaging

Paper 172 Starting at 3:40 PM, Ending at 3:48 PM

Multidetector CT, CT Angiography, and Perfusion Imaging in Acute Cerebral Ischemia and Hyperperfusion Syndromes

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PURPOSE

The purpose of this study was to evaluate the impact of multidetector CT (MD CT) in a community hospital's setting for prompt management of patients with symptoms suggestive of cerebral ischemia.

MATERIALS & METHODS

Routine as well as angiographic and perfusion computed tomography (CT/CTA/pCT) was performed in 60 patients with suspected acute ischemic symptoms, and their studies and medical records were reviewed retrospectively. The brain CT anatomical images, the calculated mean transit time (MTT), cerebral blood flow (CBF), and cerebral blood volume (CBV) perfusion images were evaluated visually. The initial studies and their interpretations were compared to subsequent brain CT and/or MR scans, and the CTA images were compared to conventional angiograms and MR angiograms, when available.

RESULTS

Forty-two patients demonstrated clinically relevant abnormal findings, while 18 patients had negative exams. Being the initial imaging studies, the MD CT studies directly impacted patient management decisions in every case. Acute endovascular or surgical intervention was enabled or contraindicated based on the results of the study in 10 patients. Matched perfusion, transit time, and blood volume defects presaged infarction in 10. Mismatched defects demonstrated reversible or salvageable ischemic penumbra in 9. Arteriosclerotic "flow significant" plaque (23 patients) and other vascular pathology was depicted, including occluded

vessels (10 patients), emboli (5 patients), spasm or vasculitis (2 patients), and dissection (1 patient). Hyperperfusion syndromes in recently revascularized patients were demonstrated.

CONCLUSION

Multidetector CT/CTA/pCT can play a major role in prompt management of patients with clinical signs of cerebrovascular ischemia, identifying major blood vessel vasculopathy and brain anatomy and flow physiology. Matched blood volume, transit time, and perfusion defects indicate permanent infarction, whereas normal blood volume but decreased regional perfusion suggests ischemic insult which is either reversible or potentially salvageable, though evolution to frank infarction can occur. Posttherapeutic hyperperfusion, which mimics ischemia, can be identified clinically.

KEY WORDS: Acute stroke syndromes, brain circulation and metabolism, CT

Paper 173 Starting at 3:48 PM, Ending at 3:56 PM

A Vascular Territory Model for Separating Normal and Alzheimer's Disease Groups Based upon Net Cerebral Blood Flow

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PURPOSE

To estimate regional cerebral blood flow using a novel method in combination with a vascular territories model in normal and Alzheimer's disease (AD) patients.

MATERIALS & METHODS

The study was approved by the Local Research Ethical Committee and all subjects gave informed consent. Sixty normal (mean age 73.1 years, range 61-87 years, 20 male) and 9 AD subjects (mean age 61.6 years, range 51-72 years, 2 male) underwent MR scanning (1.5 T, Philips ACS PT 6000 NT, Philips Medical Systems). A bolus of contrast agent (0.1 mM/kg body mass; Gd-DTPA-BMA, Nycomed UK, Ltd.) is imaged through 25 contiguous slices of the brain over 40 time points at a temporal resolution of 1.9 second using a 3D volume acquisition with echo shifting and segmented EPI data collection (PRESTO; TR = 20 ms, TE = 28 ms, FA = 10 degrees, EPI = 9, matrix = 64 x 64, voxel size = 1.80 x 1.80 x 3.0 mm for all normals and one AD subject and 1.80 x 1.80 x 3.5 for the rest of the AD subjects). For all subjects, net cerebral blood flow (NCBF) across each voxel is estimated (1) and a logarithmic transform applied to make the distribution Gaussian. A vascular territories model comprising 10 hemispherically symmetric regions (covering the anterior/middle/posterior arterial territories and the intermediate watershed regions) is fitted to a slice at the level of the upper border of the third ventricle. The mean and standard error of the log(NCBF) in each of the ten regions is calculated. The normalized mean data undergoes principle components analysis, giving the 10 modes of variation of the log(NCBF) in the normal group. All data are transformed into this normal eigenvector space. The probability that the rotated data has been drawn from a Gaussian distribution is calculated for each of the 10 dimensions. The 10 probabilities for each subject are combined as described in reference

2. The hypothesis that the AD group is not significantly different from the normal group can be tested by combining the single probabilities from each subject to obtain a single value for each group.

RESULTS

The normal group p-value is 0.54. This is consistent with the distribution of probabilities from each normal being flat, data less flat than this would be generated 54% of the time. The AD group p-value is 7.4×10^{-5} ; it is highly unlikely that this group is drawn from the same distribution as the normal group.

CONCLUSION

The novel technique for NCBF measurement demonstrates the known differences between AD and normal groups. The combination of this technique with the vascular territories model may have diagnostic value and offers the possibility of decision support tools for clinical diagnosis. The statistical model presented is novel and provides a powerful tool for the detection of magnitude and distribution abnormalities in perfusion studies. The extension of this technique from a single slice to whole brain volumes can be expected to drastically improve statistical power.

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KEY WORDS: Vascular territories, Alzheimer's disease, probability re flattening

Paper 174 Starting at 3:56 PM, Ending at 4:04 PM

Voxel-Based Morphometry in Patients Affected by Mild Form of Alzheimer's Disease

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PURPOSE

Voxel-based morphometry (VBM) is a new technique for detection of brain atrophy allowing the comparison of local gray matter concentration at every voxel in an image between two groups of subjects. We applied VBM to find gray matter changes in patients affected by mild AD.

MATERIALS & METHODS

Twenty patients with typical clinical presentation fulfilling NINCDS-ADRDA criteria for probable AD of mild severity as well as 15 healthy controls (with normal memory performance and without vascular lesions at MR imaging) were studied. The two groups were matched for age and gender. T1-weighted, volumetric MPRAGE MR scans were performed on a 1.5 T magnet yielding 150 contiguous 0.80 mm axial slices. Analysis was performed by using SPM99 running in MATLAB 5.0. Those images were analyzed with

optimized method by Good, et al.(2000). Cerebral fractional volumes [brain parenchymal (BP), gray matter (GM), white matter (WM), and CSF fraction] were calculated also.

RESULTS

Volumetric analysis showed significant difference between patients affected by mild AD and control subjects (BPF: $p = 0.01$; GMF: $p = 0.009$; CSFF: $p = 0.01$). Only white matter fraction was not significant. We found areas of gray matter loss especially located in temporal lobe mostly in the parahippocampal cortex, middle temporal gyrus, and middle frontal gyrus bilaterally.

CONCLUSION

Previous morphometric studies demonstrated that patients affected by mild AD present diffuse cerebral atrophic areas, confirmed by our study by VBM. Voxel-based morphology is a very sensible technique to find local and global gray matter concentration loss.

KEY WORDS: Cerebral atrophy, voxel-based morphometry

Paper 175 Starting at 4:04 PM, Ending at 4:12 PM

Diffusional Anisotropy Loss after Optic Nerve Crush Injury

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PURPOSE

The purpose of this study was to assess the potential of apparent diffusion coefficient (ADC) measurements to elucidate the processes of axonal degeneration in an optic nerve after traumatic injury. It has been shown that MR determination of ADC can indicate the orientation of axons and characterize injury of white matter in species with myelinated systems such as rats, cats, and humans. If ADC values successfully identify axonal injury, then they may be used to monitor response to treatments intended to ameliorate axonal degeneration.

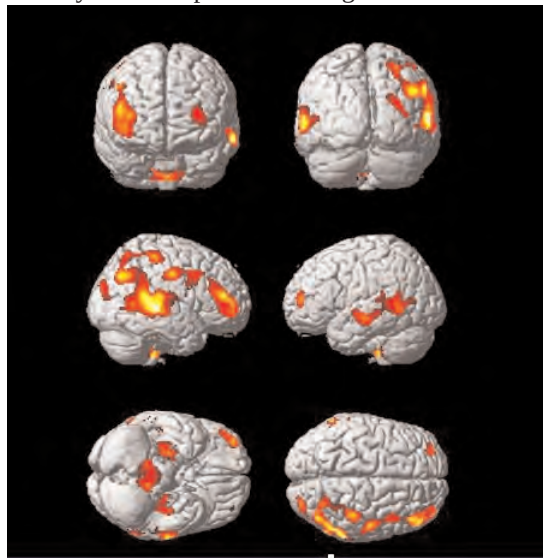
MATERIALS & METHODS

Sprague-Dawley rats were subjected to left optic nerve crush using standard techniques. Briefly, anaesthetized adult female rats were fixed in a stereotaxic frame and an incision made behind the left eye. The intraorbital portion of the left optic nerve was exposed and then crushed 2 mm behind the globe for 10 seconds with No. 5 jeweler's forceps. Nerve injury was verified by the appearance of a clearing at the crush site. After MR imaging, the rats were sacrificed by an overdose of anesthesia, and the optic nerve was isolated immediately and fixed in paraformaldehyde. The nerves were stained immunohistochemically for myelin, paranodes, and sodium and potassium channels. MR imaging was performed 6 months after injury. Diffusion imaging was performed at 4.7 T and transverse sections were obtained. Two b values ranging from 10 - 1000 sec/mm² were employed at two orthogonal directions, parallel and perpendicular directions to the optic nerve orientation. On those images, transverse (t-ADC) and longitudinal (l-ADC) diffusion coefficients

were calculated in regions of interest encompassing the crushed optic nerve and the contralateral side as a control. Anisotropy was defined simply as l-ADC/t-ADC.

RESULTS

The crushed nerves were shrunken and the cross-sectional diameter was smaller than that in the controls (approximately 0.5 mm vs 0.75 mm). In the crushed optic nerves, the t-ADC was increased compared with that of controls and l-ADC values were not changed significantly. Because of this increase in the t-ADC, there was a marked decrease in anisotropy (0.82 in injured nerves vs 2.72 in uninjured). Diffusion results were related to myelin basic protein staining.



CONCLUSION

Optic nerve crush results in reproducible loss of anisotropy due to increases in t-ADC. Posttraumatic degeneration of the nerve may be evaluated with MR imaging. This method is appropriate for evaluating response to therapy intended to be protective for posttraumatic degeneration.

KEY WORDS: Diffusion-weighted MR imaging, rat optic nerve, traumatic injury

Paper 176 Starting at 4:12 PM, Ending at 4:20 PM

Intrathecal Gadolinium-Enhanced MR Cisternography in the Evaluation of Clinically Suspected Cerebrospinal Fluid Rhinorrhea: Initial Experience

Selcuk, H. • Albayram, S. • Yilmaz, H. • Barutca, H. • Gulsen, F. • Rafee, B. • Islak, C. • Kocer, N.

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PURPOSE

In this prospective study, we evaluated the utility of MR cisternography after intrathecal administration of gadolinium in patients with clinically suspected of having cerebrospinal fluid rhinorrhea.

MATERIALS & METHODS

Fourteen patients (eleven male and three female patients aged 6-43 years) clinically suspected of CSF rhinorrhea and/or recurrent meningitis was included in this study.

Twelve patients experienced cranial trauma and two patients had previous anterior skull base surgery 4 months-1 year before the MR examination. Fat saturated T1-weighted imaging was performed in three orthogonal planes by using a 1.5 T MR (Siemens Symphony). By means of a lumbar puncture, 3-5 mL of CSF was withdrawn, 0.5 ml gadopentetate dimeglumine (Magnevist; Schering, Berlin, Germany) mixed with a 4.5 ml saline. This solution then was injected into the subarachnoid space, and needle was removed. The patients were positioned prone in the 30-40° Trendelenburg position for 30-40 minutes after withdrawal of the needle to maximize the potential for contrast agent accumulation in the intracranial basal subarachnoid cisterns.

RESULTS

No patients manifested gross behavioral changes, neurologic impairment, alteration in mental clarity, vital sign deviation from baseline, anaphylactic or other allergic reaction or seizure activity at any time during the initial 24-hour observation period following MR cisternography. In all patients, the gadopentetate dimeglumine entered the subarachnoid spaces at the base cranial cavity. Six patients showed leakage of gadolinium-enhanced fluid through the cribriform plate into the region of the ethmoid air cells and frontal sinus. One patient had leakage into right mastoid cells. No leakage was observed in seven patients; five following cranial trauma and one with meningioma that had been operated previously.

CONCLUSION

In conclusion, intrathecal gadolinium-enhanced MR cisternography is a promising technique that may permit direct, sensitive visualization of the site of spontaneous, posttraumatic or postsurgical CSF leakage.

KEY WORDS: CSF leakage, gadolinium, MR cisternography

Paper 177 Starting at 4:20 PM, Ending at 4:28 PM

Diffusion Tensor Imaging with Three-Dimensional Fiber Tractography of Traumatic Axonal Shearing Injury Resulting in Posterior Callosal "Disconnection" Syndrome

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PURPOSE

Axonal shearing injury is a primary mechanism for the cognitive and neurologic deficits resulting from head trauma. We show that diffusion tensor imaging (DTI) with 3D fiber tractography can visualize traumatic white matter disruption in the splenium of the corpus callosum causing left hemialexia due to interruption of transcallosal visual pathway fibers.

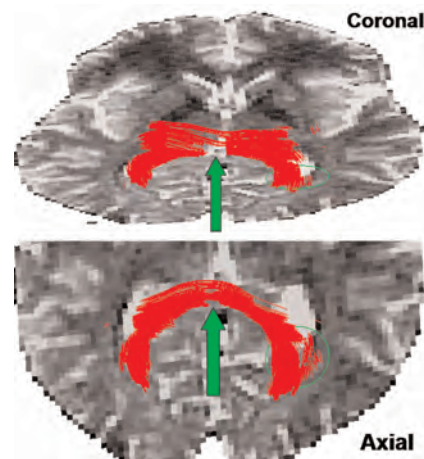
MATERIALS & METHODS

A 22-year-old man underwent MR imaging 3 days following a fall, with a Glasgow Coma Scale of 6 on presentation to the emergency department. The 1.5 T MR sequences included T1-weighted spin-echo, T2*-weighted gradient-echo, fluid-attenuated inversion recovery (FLAIR), and whole brain DTI performed with a single-shot, spin-echo, echoplanar sequence. The diffusion gradients were applied along six

noncollinear directions with $b = 1000 \text{ s/mm}^2$, as well as an additional image at $b = 0 \text{ s/mm}^2$. Tensor calculation and 3D tractography were generated using in-house software (1), with the fiber tracking performed according to the FACT algorithm (2).

RESULTS

Conventional MR images showed findings of diffuse axonal injury, with small hemorrhages at the gray-white matter junctions of the right frontal lobe on T2*-weighted imaging. Additionally, a lesion with T2 prolongation was present near the midline of the splenium of the corpus callosum, also consistent with axonal shearing injury. Diffusion tensor imaging showed that the splenial lesion had markedly reduced apparent diffusion coefficient (ADC) and markedly reduced fractional anisotropy (FA). The reduced ADC and FA were due almost entirely to a large decline in the major eigenvalue of the diffusion tensor, reflecting a large decrease in the magnitude of diffusion parallel to the white matter fiber orientation within the splenial lesion. Three-dimensional tractography of the splenium revealed an interruption of the white matter fibers in the posteroinferior aspect of the splenium (Figure). The patient was found to have left hemialexia on later neuropsychological testing. This functional deficit, known as posterior callosal syndrome, corresponds to disconnection of the right visual cortex from the language centers of the dominant left hemisphere, due to the interrupted transcallosal visual pathway within the splenium visualized on DTI tractography (3).



CONCLUSION

Diffusion tensor imaging with 3D fiber tractography can visualize white matter tract shearing injury in acute head trauma, which may have prognostic value for the cognitive and neurologic sequelae of traumatic brain injury.

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KEY WORDS: Diffusion, trauma, tensor

Paper 177A Starting at 4:28 PM, Ending at 4:36 PM**3D Volume Evaluation of Brain Tumor Changes before and after Treatment**

Yu, L.

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Syracuse, NY**PURPOSE**

The assessment of the brain tumor size before and after the treatment is critical to evaluate the treatment efficacy. The volume and shape changes of the brain tumor provide important information for evaluating the tumor status, and further for improving the diagnosis. Tumor growth or shrinkage often presents in unpredictable ways. It can be difficult for radiologists to assess the precise change of the brain tumor via the traditional 2D images in CT/MR imaging, where critical area may be missed when the slice images are captured. Thus the precise evaluation of the treatment is not likely to be achieved. Computer-assisted 3D techniques have become increasingly utilized in radiologic diagnosis. The generation of accurate anatomical 3D models from 2D medical image data provides precise information about spatial relationships between critical anatomical structures (e.g., brain tumor and eloquent cortical areas), pathology, and the shape/volume of the tumor. We develop a new 3D reconstruction technique to improve the tumor localization, volume assessment and determination of the margins of the tumors with respect to the adjacent critical brain structures.

MATERIALS & METHODS

Variable objects with known volumes and shapes were utilized for CT/MR imaging. The precisions of their volume calculation are compared between using the balloon element method and the conventional finite element method. We then perform CT/MR imaging in different types of brain lesion/tumor before and after treatment; then use automatic segmentation and 3D direct rendering to display the 3D reconstruction of tumor images. The data of volume and shape is obtained automatically by using our proposed algorithm: "Balloon Element" method.

RESULTS

The volume estimation of variable controlled objects is much more precise for balloon element method (0.27% deviation) than the conventional finite element method (2.7-5.4% deviation). Upon review by two neuroradiologists, the irregular margins and shape of different brain tumors appear to be better defined with the balloon element method software calculation.

CONCLUSION

The conventional finite element method has been used for estimating the volume for any 3D object. However, the result of this estimation is not very precise because the elements we choose from are in fixed shapes (e.g., triangles and rectangles). Often the subtle volume will be discarded by using finite element method, thus the estimation error is inevitable. Here, we use our new method, a balloon element that can be deformed and scaled in any direction to calculate the tumor volume. This flexibility enables the "balloon" be "filled" into any subtle space, so that a more precise estimation of the tumor volume can be achieved. By adapting the concept of balloon element, a 3D reconstruction and visualization soft-

ware is created to study the volume/shape changes of the brain tumor in 3D space. The software is aiming to improve the accuracy and efficiency of diagnosis, and to achieve better tumor treatment evaluation and possible surgical planning.

KEY WORDS: Brain tumor, balloon element, 3D reconstruction

Tuesday Afternoon**3:00 PM - 4:30 PM****Room 611 - 612**

(29d) Pediatrics: General
(Scientific Papers 178 - 189)

See also Parallel Sessions

(29a) Adult Brain: Vascular Imaging

(29b) Adult Brain: Functional Imaging (fMRI, MSI, MRS, PET)

(29c) Adult Brain: New Techniques,
Postprocessing/Trauma

Moderators: Patrick D. Barnes, MD
Charles R. Fitz, MD

Paper 178 Starting at 3:00 PM, Ending at 3:08 PM**Diffusion MR Imaging of Normal-Appearing White Matter in Patients with Tuberous Sclerosis Complex**

Garaci, F. G.¹ • Bozzao, A.² • Manenti, G.¹ • Ferone, E.¹ • Floris, R.¹ • Simonetti, G.¹

¹University of Rome Tor Vergata, Rome, ITALY, ²University of Rome La Sapienza, Rome, ITALY

PURPOSE

To evaluate the water diffusivity of the normal-appearing white matter (NAWM) in patients with tuberous sclerosis complex (TSC), compared with control subjects.

MATERIALS & METHODS

Diffusion and conventional MR imaging were performed in 18 patients with clinically established TSC and 18 age-matched control subjects. Apparent diffusion coefficients (ADCs) were generated and small elliptic regions of interest (ROIs) were placed manually both in perilesional NAWM and in six anatomical locations of NAWM. Perilesional ADC values were compared with those contralateral, same anatomical site. Apparent diffusion coefficient values from the predetermined sites were compared with those of control group.

RESULTS

Supratentorial ADC values were higher in TSC patients than in control subjects. Statistically significant differences were observed in all supratentorial NAWM locations. Significant increases also were seen in the perilesional NAWM compared with contralateral, same anatomical locations. Infratentorial ADC values were normal.

CONCLUSION

Significant ADC changes were measured in the supratentorial NAWM. Elevation in NAWM ADC suggests that CNS manifestations of TSC may be more diffuse than expected.

KEY WORDS: MR imaging, diffusion, TSC

Paper 179 Starting at 3:08 PM, Ending at 3:16 PM

MR Perfusion Characteristics of Cortical Tubers

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²University of Sheffield, Sheffield, UNITED KINGDOM

PURPOSE

Cortical tubers are thought to be the cause of seizures in patients with tuberous sclerosis complex. In this paper, we investigate the MR perfusion characteristics of cortical tubers in tuberous sclerosis complex.

MATERIALS & METHODS

Forty-four cortical tubers were assessed in ten patients with tuberous sclerosis complex. We also have studied nine patients with developmental delay but with normal structural MR imaging as controls. Perfusion-weighted imaging was performed with echo-planar imaging using a dynamic susceptibility contrast bolus MR perfusion technique. The ratio of the relative cerebral blood volume (rCBV) of tubers relative to the normal cortex and subjacent white matter in the contralateral hemisphere was assessed. The difference in first moment mean transit time (TTfm) between the tuber and contralateral hemisphere was determined. The asymmetry of rCBV and the TTfm of the right to left hemispheres was assessed in those with developmental delay. The ratio of rCBV and difference of TTfm of tubers were compared to controls using the Student's t-test. Correlation was performed also between the size of the tubers and the ratio of rCBV of cortical tubers to that of the contralateral hemisphere.

RESULTS

The ratio of rCBV of cortical tubers to contralateral hemisphere was reduced significantly when compared with the interhemispheric asymmetry in controls ($p < 0.01$). The difference in TTfm of cortical tuber to contralateral hemisphere was not significantly different from the interhemispheric asymmetry of the controls ($p = 0.09$) although there was a tendency towards increased transit time. There was no correlation between tuber size and relative cerebral blood volume ($p = 0.77$).

CONCLUSION

This preliminary work indicates that cortical tubers show reduced rCBV in cortical tubers but no major change in TTfm. We believe that this represents reduced relative cerebral blood flow in cortical tubers.

KEY WORDS: Cortical tubers, perfusion imaging, MR imaging

Paper 180 Starting at 3:16 PM, Ending at 3:24 PM

Perfusion and Metabolite Abnormalities in Patients with Sturge-Weber Syndrome

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PURPOSE

Sturge-Weber syndrome (SWS) is a rare congenital disease characterized by aberrant and ineffective cortical venous drainage (leptomeningeal angiomas) and cutaneous capillary angiomas. Neurologic manifestations include seizure, headache, stroke-like episodes, developmental delay, and mental retardation. The full range of manifestations is estimated to occur in only 10% of cases and there are a number of variant expressions of SWS. The purpose of this study is to investigate cerebral perfusion and metabolism in consecutive cases of SWS using advanced MR techniques.

MATERIALS & METHODS

Six consecutive patients (4 male, 2 female; age ranges from 9 months to 21 years) with a clinical diagnosis of SWS underwent MR imaging using a 1.5 T scanner. Spin-echo proton MR spectroscopic imaging (MRSI) and gadolinium bolus MR perfusion scan (PWI) were acquired in addition to routine brain MR sequences. Each patient was evaluated by a pediatric neurologist within 1 month of MR scan. MR spectroscopic imaging (TE 280 msec) consisted of three 15 mm axial slices covering from the midbrain to the centrum semiovale. The concentrations of NAA and choline were measured from the affected brain regions. Gradient-echo echo-planar PWI was acquired dynamically following the intravenous bolus injection of 0.1 mmol/kg gadolinium DTPA. The area of perfusion deficit (defined as prolonged MTT by at least 2.5 sec compared to the normally perfused brain region) was compared to the site and area of leptomeningeal angiomas.

RESULTS

One patient had bilateral disease evident from clinical manifestation of port-wine stain, ocular abnormalities (congenital glaucomas), and radiologic findings of leptomeningeal angiomas. One patient had initial presentation of unilateral cutaneous and cerebral involvement, but on subsequent imaging with postcontrast FLAIR sequence demonstrated contralateral disease as well. Perfusion abnormalities (5 of 6 patients) corresponded to the site of leptomeningeal angiomas, but were in general equivalent or smaller compared to the area affected by angiomas. One patient had no perfusion deficit. These patients also demonstrated different metabolite profile. Decreased NAA level was evident in only 2 of 6 patients, corresponding to area of cerebral atrophy and leptomeningeal angiomas. In one patient who was evaluated at his early presentation of disease within 2 years of age, there was slight elevation of choline level in the affected brain region but NAA was within normal limits. In three other patients, no metabolite abnormality was present.

CONCLUSION

MR perfusion and spectroscopy complement conventional MR imaging by providing hemodynamic and metabolic information in patients with SWS. In a series of 6 patients we find a wide range of clinical as well as radiologic expressions of this disorder. Correlating these imaging findings with clinical status in a larger patient cohort over a period of time may yield information on the natural history of this disorder.

KEY WORDS: Sturge-Weber syndrome, perfusion, spectroscopy

Paper 181 Starting at 3:24 PM, Ending at 3:32 PM

Improved Diffusion MR Imaging of Premature Newborns Using an MR Compatible Incubator and a Specialized Neonate MR Coil

Veeraraghavan, S. • Mukherjee, P. • Miller, S. P. • Charlton, N. • Partridge, S. C. • Xu, D. • Henry, R. G. • Barkovich, A. • Vigneron, D. B.

University of California San Francisco
San Francisco, CA

PURPOSE

MR diffusion tensor imaging (DTI) is a powerful technique for assessing tissue microstructure. Although primarily used in adult studies, DTI may be especially valuable for the study of brain development and injury in premature newborns. Technical challenges for neonatal DTI include: the ability to perform MR exams on young, unstable premature babies; the small size of the neonatal head for which the adult head coil is suboptimal; and potential motion artifacts in unsedated babies. These problems were addressed in this serial DTI study of premature brain development by using an MR compatible incubator incorporating a specialized neonatal head coil (1).

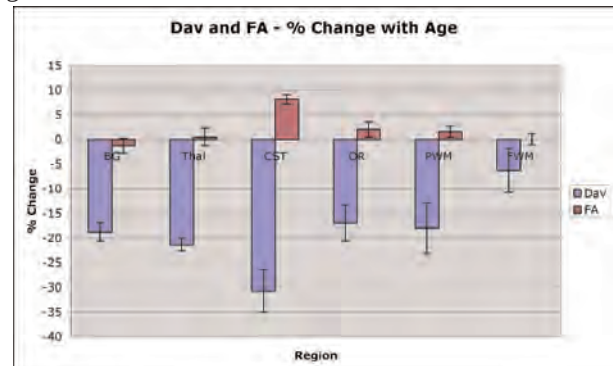
MATERIALS & METHODS

A total of 28 DTI MR exams were acquired from 18 premature newborns with no evidence of white matter injury on conventional MR imaging. The subjects were born at estimated gestational ages of 24-34 weeks and were imaged initially between 28-35 (median 33) weeks and were followed up between 35-43 (median 37) weeks using an MR imaging-compatible incubator with a specialized high-sensitivity neonate head coil (1). The whole-brain axial interleaved DTI images were acquired in 4.8 minutes at a 1.4 x 1.4 x 3.0 mm spatial resolution using a single-shot EPI sequence with 6 gradient directions, $b = 0$ and 600 s/mm², TE = 99.5 ms, TR = 7s, and 3 repetitions. Region of interest analyses were performed for the directionally averaged apparent diffusion coefficient (Dav), each eigenvalue (λ_1 , λ_2 , λ_3), fractional anisotropy (FA), and relative anisotropy (RA) localized to: basal ganglia (BG), thalamus (Thal), corticospinal tracts (CST), optic radiations (OR), parietal white matter (PWM), and frontal WM (FWM). Image signal-to-noise ratio (SNR) measurements were compared to prior serial DTI studies of preterm newborns acquired using a standard head coil (2).

RESULTS

The MR compatible incubator improved the ease and safety for MR serial studies of young, unsedated preterm neonates with a 40-50% increase in SNR compared to a standard head

coil. Significant ($p < 0.05$) differences in diffusion parameters were noted between regions and with increasing age. Serial changes are shown in the figure demonstrating that Dav decreased significantly with age in BG ($p < 0.0001$), CST ($p < 0.0001$), or ($p = 0.0002$), PWM ($p = 0.003$), and Thal ($p < 0.0001$) and that FA increased significantly in CST ($p < 0.0001$). No significant differences were found between right and left sides.



CONCLUSION

The MR-compatible incubator with its high sensitivity neonatal head coil improved MR exams of preterm infants by providing a warm, quiet, well monitored environment and a significant increase in image SNR. Serial DTI studies of premature neonates demonstrated significant regional and maturational differences in diffusion parameters in subjects with normal imaging findings. Correlations with outcome in abnormal infants are pending upon subsequent neurologic follow-up.

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KEY WORDS: Neonate, MR incubator, diffusion

Paper 182 Starting at 3:32 PM, Ending at 3:40 PM

Medullary Venous Pathology in Neonates

Feygin, T. • Simon, E. M. • Bilaniuk, L. T. • Pollock, A. N. • Zimmerman, R. A.

Children's Hospital of Philadelphia
Philadelphia, PA

PURPOSE

Review of imaging findings of pathology of the medullary veins in neonates.

MATERIALS & METHODS

Retrospective review of MR imaging (T1-, T2-weighted, FLAIR, 2D FLASH gradient-echo sequences) of 11 neonates with medullary vein thrombosis or marked medullary vein engorgement was carried out. Six neonates were premature (range: 29 to 36 weeks) and five were full term. Patients presented for imaging at an average of 32.8 days of life (premature), 24.4 days of life (term infants).

RESULTS

Imaging features of thrombosis and/or engorgement of the medullary veins included marked susceptibility effect on gradient-echo sequences and linear radiating T2 hypointense vessels in the deep white matter. Frontal lobe involvement predominated. Occasionally, the vessels demonstrated intrinsic T1 shortening, dependent on the stage of clot formation. In four cases, deoxyhemoglobin on gradient-echo sequences within the abnormal medullary veins was the only imaging finding. Predisposing factors included congenital heart disease (n = 3) and perinatal infection (n = 3), and dehydration (n = 1).

CONCLUSION

Thrombosis and/or engorgement of cerebral medullary veins is uncommon, but may be encountered in premature and full term neonates, particularly in the setting of congenital heart disease or perinatal infection. This entity should be considered as an etiologic factor when atypical patterns of periventricular leukomalacia and/or prior hemorrhage are encountered on MR studies in older children. T2* gradient-echo imaging may be crucial for diagnosis during the acute presentation.

KEY WORDS: Medullary veins, thrombosis, neonates

Paper 183 Starting at 3:40 PM, Ending at 3:48 PM

Central Nervous System Imaging in Childhood Leukemia

Porto, L.

Uni-Klinikum Frankfurt
Frankfurt, GERMANY

PURPOSE

To document the imaging abnormalities seen in the central nervous system (CNS) of childhood leukemia or as complications of its treatment.

MATERIALS & METHODS

MR images and CT scans were reviewed retrospectively in 22 children and adolescents with neurologic manifestations/complications of leukemia or its treatment.

RESULTS

Among the 22 patients, nine had two or more different CNS abnormalities. The imaging abnormalities seen in 15 patients before or during treatment included sinus thrombosis, cortical vein thrombosis, cerebral hemorrhage, meningeal leukemia, infections, skull leukemic infiltration, and treatment-related neurotoxicity. After therapy, seven patients had CNS abnormalities, including secondary brain tumors, skull tumor, mineralizing microangiopathy, leukoencephalopathy, transient white matter abnormalities, spinal intradural hematoma, chronic subdural hematoma, radiation necrosis, meningeal leukemia, and leukemic infiltration at the vertebral body.

CONCLUSION

Central nervous system complications are related to the inherent risk of leukemia itself, to the treatment method, and to the duration of survival.

KEY WORDS: Children, leukemia, nervous system

Paper 184 Starting at 3:48 PM, Ending at 3:56 PM

Isotropic Diffusivity Changes of Centrum Semiovale in Children with and without Developmental Delay: Diffusion MR Imaging with Segmentation-Based Measurement

Bun, K. • Ito, R. • Kitahara, S. • Murata, K.

Shiga University of Medical Science
Otsu, JAPAN

PURPOSE

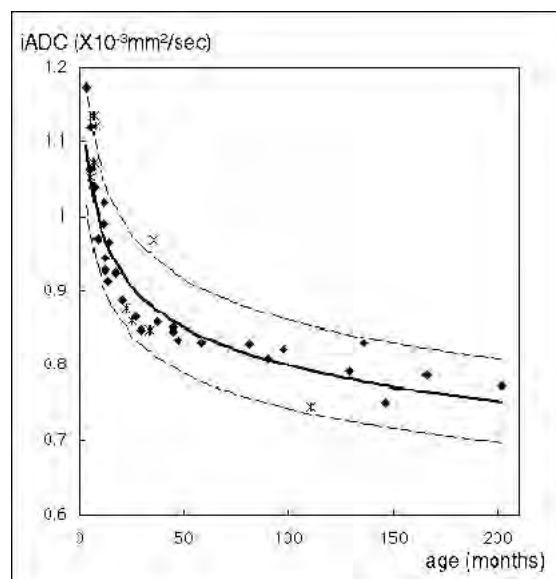
To characterize maturational changes of isotropic apparent diffusion coefficient (ADC) in centrum semiovale segmented from supraventricular slab in children without developmental delay and abnormalities on conventional MR imaging. Using the obtained trends, to assess the isotropic ADC values of children with developmental delay.

MATERIALS & METHODS

In this study, brain MR examinations of 39 subjects (19 girls and 20 boys, age: 3 months-16 years, mean: 44.4 months) were performed for various reasons (e.g., low birth weight infant, febrile seizure, headache) and described no abnormalities on conventional MR images. We retrospectively reviewed their medical records and divided the children into two groups, children without (n = 30) and with (n = 9) developmental delay. Permission for usage of these data for research purposes was obtained from guardians and this reporting was approved by the institutional review board. MR imaging was performed on a 1.5 T clinical MR system. Diffusion-weighted images [echo-planar pulse sequence; 3000-4500/103-110 msec (TR/TE); field of view 22 cm; 5 mm thick with a gap of 0.5-1.5 mm; scan matrix 96 x 96] of 15 or 19 transverse locations were obtained. Diffusion sensitization gradients were applied in three orthogonal axes with b-value of 1000 sec/mm². We generated pixel-by-pixel isotropic ADC maps from the diffusion-weighted images and images without diffusion sensitization. Spin-echo T1-weighted images corresponding to the location of diffusion-weighted images were obtained and white matter was segmented automatically using brain image analysis tools, FSL (the Image Analysis Group, FMRIB, Oxford, UK). A supraventricular slab that included continuous imaging locations starting inferiorly from the top of the lateral ventricles was determined. We obtained a mean of isotropic ADC values within the area corresponding to the segmented white matter in the slab for each subject. Nonlinear regression analysis was used for evaluating the relationship between the mean of isotropic ADC values and subject age in children without developmental delay. The resulting graph was fit with exponential regression model. Then, we plotted the data of the children with developmental delay on the graph and assessed whether those were within the 95% confidence interval of mean ADC value at each age in children without developmental delay or not.

RESULTS

The graph of mean isotropic ADC value vs subject age is shown in Figure. The data of children without developmental delay (diamond shape) are fit to a monoexponential model (solid line) with determination coefficient 0.909. The dashed lines denote the upper and lower limits of the 95% confidence interval. The points with a shape of x show the data of children with developmental delay.



CONCLUSION

In the children without developmental delay, the graph of the mean isotropic ADC value of centrum semiovale segmented from supraventricular slab vs age is fit with monoexponential model. Most data of children with developmental delay are within the 95% confidence interval of the graph.

KEY WORDS: Diffusion MR imaging, developmental delay, isotropic diffusivity

Paper 185 Starting at 3:56 PM, Ending at 4:04 PM

Interobserver Variability in Radiographic Evaluation of Suspected Cerebrospinal Fluid Shunt Obstruction

Shroff, M. M. • Mater, A. • Drake, J. • Goldman, R.

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Toronto, ON, CANADA

PURPOSE

To measure interobserver variability of plain radiographs (shunt series) and CT scans in a group of children undergoing evaluation for suspected shunt obstruction.

MATERIALS & METHODS

This is a retrospective study with approval from the institutional research ethics board. Shunt series and CT brains obtained in 98 consecutive patients over a 10-month period were reread independent of clinical input and previous interpretations. Comparisons with the last recent shunt series and CT brains were available in all and also were documented. Findings of the shunt series were classified into: 1) normal, 2) disconnection and site of disconnection, 3) tip retraction out of the abdomen, 4) kink in shunt tubing, 5) no tip movement from prior examination (loculation), and 6) other findings. For CT of the brain, findings were classified into: 1) normal, 2) hydrocephalus, no change from previous CT, 3) hydrocephalus, increase from previous CT, 4) hydrocephalus, decrease from previous CT, 5) other new abnormality. Comparisons were made with previous transcribed reports and discrepancies were documented. Discrepant

reports were analyzed further into significant (which would impact clinical management) and not significant (which would not change management) by an independent observer.

RESULTS

There were 7 discrepancies in the interpretation of shunt series. These when viewed alone theoretically could be considered significant. However, in all these patients further management was based on review of clinical findings and more importantly correlation with CT findings. There were 8 significant discrepancies in CT reports, which related to changes in ventricular size. Four out of these 8 patients underwent shunt revisions. More than half of the CT discrepancies were due to complex loculated hydrocephalus with multiple ventricular catheters.

CONCLUSION

Interobserver variability occurred in up to 7.14% of patients in evaluation of shunt series and 8.16% of CT brains when evaluating for suspected shunt obstruction. Ventricular size particularly on CT often merits objective measurements compared to previous studies particularly when changes in size are subtle or when there is complex loculated hydrocephalus with multiple shunts.

KEY WORDS: Shunt obstruction, hydrocephalus, CT

Paper 186 Starting at 4:04 PM, Ending at 4:12 PM

Cerebral Spinal Fluid Flow Velocity in the Foramen Magnum of Normal Subjects in Relation to Age

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Madison, WI

PURPOSE

We have observed higher CSF velocities in pediatric patients than in adult patients with a Chiari I malformation. We then undertook a study of CSF flow as a function of age in subjects with apparently normal posterior fossae.

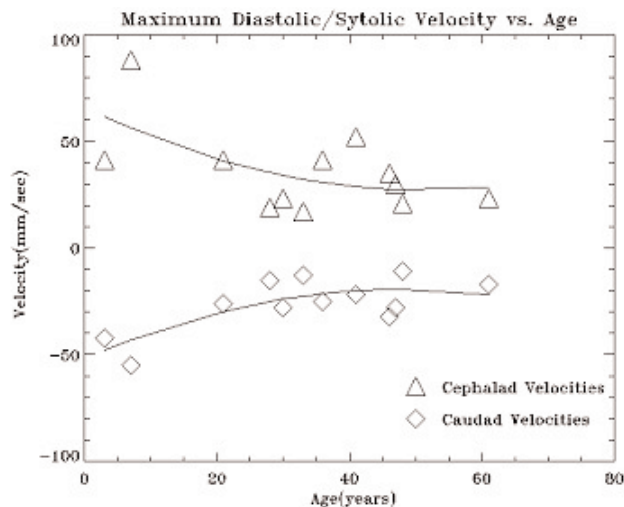
MATERIALS & METHODS

Children who were undergoing MR imaging for conditions not anticipated to affect CSF flow and normal adult volunteers had a conventional flow sensitive PC MR image to measure CSF flow throughout the cardiac cycle. The sequence included flow sensitized images at 14 times throughout the cardiac cycle. The spatially and temporally resolved peak velocities were recorded. The peak cephalad and caudad velocities in the cycle were tabulated and were plotted as a function of age. The data were fitted to a second order polynomial curve. The study was approved by the IRB and conforms to HIPAA requirements.

RESULTS

Ten adults ranging in age from 22 to 61 years and 2 pediatric patients have been enrolled to date. Peak CSF caudad and cephalad velocities were greater in the children than in the adults (Figure). Peak velocities appeared not to change significantly with age after the second decade of life. Figure: Peak caudad (positive values) and cephalad (negative values) CSF velocity (mm/sec) during the cardiac cycle in normal subjects. Note that velocities appear to diminish

during the first decade of life but remain relatively constant after the second decade (only preliminary data has been included in the table).



CONCLUSION

Cerebral spinal fluid velocities are greater in children than in adults. In studies of CSF flow in pathologic conditions, approximate age matching is required between subjects and controls.

KEY WORDS: Chiari I malformation, CSF flow, MR imaging

Paper 187 Starting at 4:12 PM, Ending at 4:20 PM

Contribution of Cranial MR Imaging in Combination with CT in the Initial Evaluation of Infants and Children with Nonaccidental Cerebral Injury: Correlation with Presence of Retinal Hemorrhage

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¹University of Arkansas for Medical Sciences, Little Rock, AR, ²Arkansas Children's Hospital, Little Rock, AR

PURPOSE

To study a large group of infants and children admitted to a children's hospital with documented nonaccidental cerebral injury (NACI) who had cranial CT, MR imaging, and ophthalmologic examination as part of an initial evaluation in order to determine the added utility of cranial MR imaging in this setting and the significance of the presence of retinal hemorrhage (RH) for the prediction of severity of cerebral injury.

MATERIALS & METHODS

Ninety-five consecutive infants and children age newborn to 4 years were admitted from 1999-2003 with documented NACI. Forty children in this group who underwent concurrent CT and MR imaging near the time of admission were included in this study. CT examinations were performed on the day of admission without contrast or sedation. MR examinations were performed within an average of 51 hours of the admission CT (range 0-12 days). MR imaging was performed with a 1.5 T magnet. Sequences included sagittal T1, axial proton density or FLAIR, T2-weighted and gradient-echo images in all cases. Twenty-seven of 40 (68 %) had diffusion-weighted imaging. Patient records, CT and MR

reports were reviewed retrospectively with specific attention to the presence of extradural hemorrhage (EDH), subdural hemorrhage (SDH), parenchymal hemorrhage (PH), cerebral ischemic changes (CIC), and RH. Presence of RH was correlated with the severity of cerebral injury. A maximum cerebral injury scale of 3 included the presence of SDH or EDH (1 point), PH (1 point), and CIC (1 point).

RESULTS

Three of 40 (8%) patients had EDH, 30/40 (75%) patients had SDH, 9/40 (23%) patients had PH, and 15/40 (38%) patients had CIC. In all cases, EDH, SDH, and PH were detected by both CT and MR imaging. In 7/15 (47%) of patients with CIC, ischemic changes were seen on CT but in all 15/15 (100%) patients with CIC, MR imaging was positive. This difference is statistically significant ($p < .05$). The 18 patients with RH had a higher cerebral injury score (1.72) than the 22 patients without RH (0.85). This difference was statistically significant ($p < .05$).

CONCLUSION

In this study, although CT and MR imaging each detected all cases of EDH, SDH, and PH, MR imaging detected over twice as many cases of CIC compared to CT, a statistically significant finding indicating added value for the MR examination. The presence of RH was associated with a statistically significant increased cerebral injury score in this group of infants and children with NACI.

KEY WORDS: Nonaccidental cerebral injury, retinal hemorrhage, MR imaging

Paper 188 Starting at 4:20 PM, Ending at 4:25 PM

Primitive Neuroectodermal Tumor of the Optic Chiasm in a Pediatric Patient

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¹Emory University School of Medicine, Atlanta, GA,

²Children's Healthcare of Atlanta at Scottish Rite, Atlanta, GA

PURPOSE

To illustrate a rare case of a PNET of the optic chiasm which demonstrated imaging and spectroscopy findings characteristic of an optic glioma.

MATERIALS & METHODS

MR imaging and MR spectroscopy obtained using a 1.5 T Siemens MR scanner. Imaging protocol of multiplanar T1, T2 and FLAIR sequences, both pre and postcontrast. Multivoxel spectroscopy technique consisted of short and long TE sequences.

RESULTS

The patient was a 9-month-old Caucasian girl who presented with rotatory and lateral nystagmus along with intermittent left cranial nerve VI palsy. An MR image of the brain revealed an intensely enhancing mass originating in the optic chiasm and hypothalamus with involvement of the cisternal portions of the optic nerves, optic tracts nearly to the level of the geniculate ganglion as well as the left optic nerve at the orbital apex. The lesion was isointense on T1-weighted imaging and of isointensity to slightly hyperintense on T2-weighted imaging. MR spectroscopy revealed an abnormal-

ly low n-acetylaspartate (NAA) peak, elevation of choline and myoinositol peaks, and a decrease in the creatine peak. MR and MR spectroscopy findings were most consistent with an optic glioma. A subsequent biopsy yielded a diagnosis of PNET. The specimen was sent out also to other well known neuropathologists who all confirmed this diagnosis.

CONCLUSION

This case illustrates a rare example of a pediatric patient with a PNET of the optic chiasm despite imaging and spectroscopy findings which were characteristic of an optic glioma.

KEY WORDS: PNET, optic, glioma

Paper 189 Starting at 4:25 PM, Ending at 4:30 PM

Initial Evaluation of Intra and Extraconal Capillary Hemangioma with Doppler Ultrasound Could Mimic an Arteriovenous Fistula: A Pediatric Case Report

Roldan-Valadez, E.¹ • Solorzano-Morales, S.^{2,1} • Facha, M.¹ • Corona-Cedillo, R.^{1,1}

¹Medica Sur Clinic & Foundation, Mexico, MEXICO,

²National Institute of Pediatrics, Mexico, MEXICO

PURPOSE

Although most pediatric orbital tumors are benign, a timely diagnosis and treatment is important to prevent bony disfigurement, amblyopia, optic nerve damage, or progression of a potentially curable malignancy. The most common benign orbital masses that spare the optic nerve and globe are of vascular origin. They are associated with relative intact visual function in comparison to lesion size but may be disabling because of ptosis, proptosis, pain, extraocular muscle dysfunction, extension, or intralesional hemorrhage. Capillary hemangioma presents primarily during the first year of life. They occur most often in the superior nasal quadrant or the intraconal space with increase in size during 6 to 10 months and then gradually involute, although they may enlarge at a disturbing rate in early childhood. These tumors may have a greater orbital involvement than that suspected from clinical examination, and may even extend intracranially through the superior orbital fissure, optical canal, and orbital roof. The use of Doppler ultrasound in the evaluation of the vascular pathology of the orbit is an initial nonexpensive choice in developing countries. Capillary hemangioma in and around the orbit may have an arterial supply from either or both the external or internal carotid arteries that could mislead the Doppler ultrasound diagnosis from capillary hemangioma to an orbital fistula.

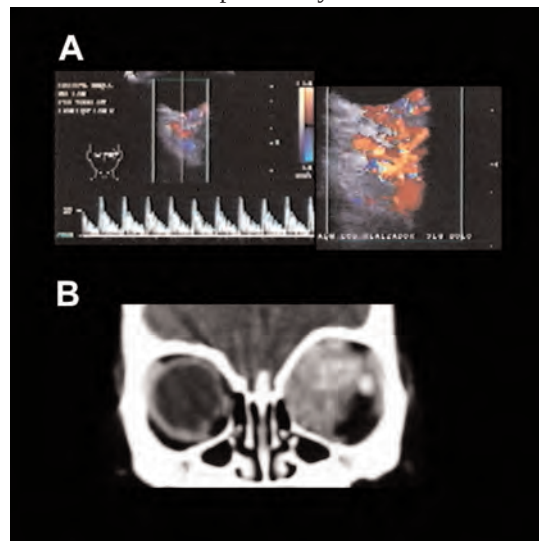
MATERIALS & METHODS

An 18-month-old female presented since birth with progressive left eye proptosis and vascular conjunctival congestion. Doppler ultrasound examination revealed an intraconal highly vasculated lesion that, after intravenous (iv) administration of an echo-enhancing agent (galactose/palmitic acid) showed a dilated vascular structure with "corkscrew" appearance and flow turbulence; this finding lead to the diagnostic possibility of an orbital fissure. CT scanning showed a heterogeneous extra and intraconal lesion adjacent to the internal rectus muscle causing globe displacement and osseous expansion; enhanced CT scan revealed a prominent vascular, tortuous structure, at this point the possibility of an orbital fissure could not be ruled out yet. Arterial angiogra-

phy showed irrigation by branches from both the internal (ophthalmic and orbitofrontal) and external (infraorbital) carotid arteries to the orbit lesion. No fistula was evident. Surgery was performed and the pathology report read capillary hemangioma.

RESULTS

Diagnosis of orbital fissure is extremely rare. In this case, the initial Doppler ultrasound evaluation, and with iv administration of an echo-enhancing agent, made an orbital fissure a strong consideration, which could not be ruled out on the CT examination. The evaluation with arterial angiography eliminated the orbital fissure possibility.



CONCLUSION

Arterial angiography is mandatory for precise vascular definition under the suspicion of an orbital fissure (venography usually is not helpful when orbital fissure is suspected since the supply is arterial). When encountered with a capillary hemangioma the Doppler ultrasound evaluation could be misleading; therefore, CT and arterial angiography examination are mandatory to rule out the differential diagnosis of an orbital fissure if suspected.

KEY WORDS: Hemangioma, Doppler, fistula

Tuesday Afternoon

3:00 PM - 4:30 PM

Room 602 - 603

(30) ELC Workshop B: PowerPoint for Advanced Users

- H. Christian Davidson, MD
- Richard H. Wiggins, III, MD

Tuesday Afternoon**4:40 PM - 5:40 PM****Room 606 - 609****(31) ELC Lecture F: Overview of Digital Cameras and Camcorders**

- Richard M. Berger, MD
— Richard H. Wiggins, III, MD

Tuesday Afternoon**4:40 PM - 6:10 PM****Room 611 - 612****(32) Interesting Pediatric Case Session (ASPNR)**

Moderators: Charles M. Glasier, MD
Gary L. Hedlund, DO

Tuesday Afternoon**4:40 PM - 6:10 PM****Ballroom 6 A****(33) Developmental Lesions in the Head and Neck (ASHNR)****(33a) Congenital Malformations of the Ear**

- H. Christian Davidson, MD

(33b) Approach to Imaging of the Globe and Orbit

- Clifford J. Belden, MD

(33c) Developmental Anomalies of the Neck

- Robert W. Dalley, MD

Moderators: Suresh K. Mukherji, MD
Anton N. Hasso, MD, FACR

Congenital Malformations of the Ear*H. Christian Davidson, MD*

H. Christian Davidson is Associate Professor and Executive Vice Chairman of Radiology at the University of Utah. Dr. Davidson received his MD from the University of Utah, received a MS in Medical Informatics at Stanford University, completed Fellowship in Neuroradiology at the University of Utah.

LEARNING OBJECTIVES

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

- 1) Describe embryology and anatomy of the ear
- 2) Review common congenital malformations of external and middle ear
- 3) Review common congenital malformations of the inner ear

PRESENTATION SUMMARY

During the lecture, basic embryology and anatomy of the ear will be reviewed, drawing distinctions between the development of the inner ear versus the middle external ear complex. Common congenital lesions of the ear and the corresponding imaging manifestations will be presented in detail.

Approach to Imaging of the Globe and Orbit*Clifford J. Belden, MD***PRESENTATION SUMMARY**

The role of imaging in the evaluation of a variety of congenital and developmental abnormalities of globe and orbit will be presented. The normal development of the orbit and globe will be discussed briefly. The presentation will center on the typical clinical scenario these patients are encountering and the role imaging plays in diagnosis and treatment planning. The role of CT and MR imaging of patients with microphthalmia and macrophthalmia, both unilateral and bilateral, will be discussed. Congenital/developmental orbital masses, including dermoids, epidermoids, teratomas, and encephaloceles will be presented. Finally, the evaluation of infants with leukocoria will be discussed.

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Developmental Anomalies of the Neck

Robert W. Dalley, MD

LEARNING OBJECTIVES

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

- 1) Define the common branchial arch and cleft anomalies of the neck
- 2) Review thyroglossal duct anomalies
- 3) Identify vascular and lymphatic anomalies of the neck
- 4) Describe dermoid cysts in the neck

PRESENTATION SUMMARY

Branchial anomalies are classified by the pouch or cleft of origin as either a first, second, third, or fourth branchial cleft anomaly. These may be in the form of a cyst, tract, or fistula. Each of these lesions appear in characteristic locations in the neck, which allows accurate classification. The most common are the second branchial cleft cyst located in the anterior cervical space near the carotid bifurcation and the first branchial cleft cyst at the tail of the parotid gland. Some branchial cleft cysts may develop secondary carcinoma within the cyst. The thyroglossal duct is a primitive tract of descent of the thyroid gland from its origin in the foramen cecum in the posterior tongue as it descends anterior to the hyoid bone and between the thyroid cartilage and the thyroid strap muscles and comes to rest below the cricoid cartilage. Lesion may be in the form of ectopic thyroid tissue or cysts anywhere along this tract. Thyroglossal duct cyst may rarely develop a secondary carcinoma. Vascular lesions include capillary and cavernous hemangioma, capillary malformations (port wine stain), venous malformations, and arteriovenous malformation and arteriovenous fistula. Capillary hemangioma often develops rapidly in the neonatal period and then spontaneously involutes. Cavernous hemangioma often contains characteristic phleboliths. Many of these capillary, arterial and venous anomalies are multispatial, traversing two or more fascial spaces. Lymphatic anomalies are usually in the form of a lymphangioma (cystic hygroma) commonly found in the submandibular and posterior cervical spaces. They may be unilocular or multilocular in a single space or they can also be transspatial. Dermoid cysts in the neck may contain fluid, fat, calcium, bone and/or teeth. The central tongue and the orbit are the most common locations.

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Tuesday Afternoon

4:40 PM - 6:10 PM

Ballroom 6 B/C

(34) Advanced Imaging Seminar - Perfusion, Permeability, and Beyond

(34a) An Overview of Perfusion Parameters

— Howard A. Rowley, MD

(34b) MR Imaging vs CT Techniques

— Michael H. Lev, MD

(34c) Permeability Imaging

— James M. Provenzale, MD

(34d) Reactivity and Oxygen Extraction Fraction

— David J. Mikulis, MD

Moderators: Timothy P.L. Roberts, PhD
Howard A. Rowley, MD

An Overview of Perfusion Parameters

Howard A. Rowley, MD

LEARNING OBJECTIVES

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

- 1) Define three (3) major types of perfusion parameter maps used in CT and MR
- 2) Assess and discuss the techniques and pitfalls in parameter map processing

PRESENTATION SUMMARY

Perfusion is a complex physiologic process that is characterized best with the aid of parameter maps. Traditional older perfusion methods such as PET, XeCT, and SPECT yield a

global measure of overall blood delivery, cerebral blood flow (CBF), measured either in absolute terms or expressed as a ratio to normal tissue. There is now increasingly rapid clinical adoption of new perfusion techniques based on IV contrast bolus methods, captured with either CT or MR dynamic first-pass imaging. These large CT or MR data sets can be processed quickly to produce a variety of parameter maps to aid in diagnosis. Three major families of CT/MR perfusion parameter maps are prepared, each reflecting a different facet of blood delivery: 1) temporal dynamic maps, describing arrival times, delay, and dispersion (e.g., mean transit time, MTT; time to peak, TTP, bolus arrival time, BAT); 2) cerebral blood volume (CBV) maps, reflecting a snapshot of capillary level autoregulation; and 3) cerebral blood flow (CBF) maps, depicting net delivery of blood at the capillary level. Since $\text{CBF (ml/100 g/min)} = \text{CBV (ml/100g)/MTT (sec)}$, all 3 parameters ideally should be known to fully describe the perfusion process and understand the state of autoregulation. The richer dynamic data set offered by CT and MR imaging provides an advantage over some of the traditional perfusion techniques and helps to counterbalance any shortfall in absolute CBF quantification. Several groups have shown that quantification of CT and MR perfusion data requires picking an appropriate arterial input function (AIF) to deconvolve the data set prior to map preparation. Penumbra, reperfusion, luxury perfusion, misery perfusion, and other important clinical blood flow issues can be identified using the powerful combination of these parameters. Perfusion parameter maps now are used commonly to triage acute stroke patients and follow effects of treatment, both in trials and in routine clinical application.

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Disclosure: The author of this presentation has indicated an affiliation with GE Medical Systems, Amersham Health, Genentech, Paion Corp: Consulting Fees.

MR Imaging vs CT Techniques

Michael H. Lev, MD

LEARNING OBJECTIVES

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

- 1) Describe the clinical indications for, relative merits of, and technical assumptions underlying, the two most common CT methods of measuring cerebral blood volume (CBV): quantitative, single slab, "first pass" cine CT perfusion vs whole brain "perfused blood volume" imaging using CT angiography (CTA) source images (CTA SI)
- 2) Explain the analogy between, as well as the clinical significance of MR diffusion, perfusion vs CT blood volume, blood flow "mismatch," in the triage of acute stroke patients to thrombolytic therapy
- 3) Distinguish the advantages and pitfalls of using MR or CT perfusion imaging to grade brain tumors, select targets for stereotactic biopsy, or distinguish radiation necrosis from recurrent tumor, compared to both conventional, contrast-enhanced imaging techniques, as well as to other "functional" techniques including MR spectroscopy

PRESENTATION SUMMARY

Perfusion imaging is being advocated increasingly as a clinically relevant imaging modality for the diagnosis and triage of patients with acute stroke, brain tumors, and other neurovascular disorders, such as vasospasm following aneurysmal subarachnoid hemorrhage. This lecture will survey the clinical indications, essential technical details, and the strengths and weaknesses - as well as the pearls and pitfalls - of available perfusion methods, with special attention to a comparison between MR and CT techniques.

Disclosure: The author of the presentation has indicated that he will be discussing/presenting an unapproved/investigative use of IA Thrombolysis. The IA Thrombolysis is made by GE Medical Systems and Amersham Health.

Permeability Imaging

James M. Provenzale, MD

LEARNING OBJECTIVES

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

- 1) Describe and assess the importance of the role of permeability in assessing tumor therapeutic response
- 2) Describe various techniques for imaging permeability
- 3) Show examples of tumor vessel permeability to antiangiogenesis therapy

PRESENTATION SUMMARY

The concept of permeability plays an important role in many CNS disease states. Leakiness of the blood-brain barrier allows extravasation of contrast material and is the basis for contrast enhancement of CNS lesions. It stands to reason that measurement of permeability, including rates of contrast material leakage, will reveal significant information about a number of disease states. The most important role for permeability imaging is likely brain tumor imaging. In this presentation, a number of methods for measuring rate of contrast material leakage as well as permeability rates will be discussed in the context of tumor imaging. The roles of perme-

ability imaging in assessing new tumor therapies also will be explained. Finally, because the size and nature of contrast material agents plays an important role in the rates of leakage, the use of novel contrast agents in permeability imaging will be discussed.

Disclosure: The author of this presentation has indicated an affiliation with Philips Medical Systems: Research grant.

The author of the presentation has indicated that he will be discussing/presenting an unapproved/investigative use of Magnanist using 0.2 mmo/kg dose. The Magnanist is made by Berlex Imaging.

Reactivity and Oxygen Extraction Fraction

David J. Mikulis, MD, Adrian Crawley, MD, Andrea Kassner, MD

LEARNING OBJECTIVES

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

- 1) Identify and examine the ability of MR imaging to probe two fundamental physiologic features of the brain microcirculation: cerebrovascular reactivity and delivery of oxygen to the tissues
- 2) Analyze the role these methods have in assessing patients with vascular abnormalities
- 3) Contrast and discuss the issues concerning clinical implementation of these methods

PRESENTATION SUMMARY

The recent merger of high field MR imaging technology with parallel acquisition strategies promises to revolutionize morphologic and functional MR imaging. As these technologies mature, the clinical impact, especially for functional studies, will likely be similar to, or even greater than, that seen when echo-planar imaging legitimized MR imaging as a serious functional imaging technology in the early nineties. It is coming at a time when practicing neuroradiologists are seeing an increase in clinical demand for information concerning brain function and physiology especially in the management of acute ischemic stroke. The focus of this presentation is to discuss two emerging functional techniques that probe fundamental physiologic features of the brain: cerebrovascular reactivity (CVR) and oxygen utilization represented by oxygen extraction fraction (OEF) and cerebral metabolic rate of oxygen (CMRO₂). Although positron emission tomography (PET) has been used traditionally to acquire this information, noninvasive MR methods are available now (1, 2). Acquisition of CVR data using MR imaging requires control of brain blood flow that can be achieved, for example, through manipulation of inhaled CO₂ - a technique we have implemented clinically by using a rebreathing circuit to control CO₂ (a potent vasodilator) during blood oxygen level dependent (BOLD) imaging (1). We have found the resulting CVR maps useful in assessing the regional impact of vascular narrowing in patients with moyamoya disease. We also have observed focal CVR abnormalities in tissues adjacent to arteriovenous malformations, a finding that raises questions about the validity of functional MR imaging (fMRI) maps obtained in these patients. These maps assume intact CVR if not false negative activation of eloquent cortex may be reported. Oxygen extraction fraction

measurements can be obtained through acquisition and thresholding of absolute T₂ measurements (3). The ability to measure OEF may become useful in the setting of acute ischemic stroke or in determining the direct effect of proximal vascular stenosis on the tissue itself. We envision the potential to triage morphologically significant stenoses into two categories: those with normal OEF vs those with increased OEF, the latter indicating greater physiologic compromise of the tissue a condition with higher clinical urgency. This becomes even more useful in assessing patients with multivessel stenoses. We are now exploring the feasibility of clinically implementing CMRO₂ measurements obtained from OEF and arterial spin labeled CBF images. The derivation of these parameters and clinical implementation of the relevant MR imaging techniques will be discussed, clinical examples will be shown, and comment will be made on their expected clinical impact.

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Tuesday Afternoon

5:40 PM - 6:10 PM

Room 606 - 609

(35) ELC Roundtable: Q & A with Today's Speakers

- Richard M. Berger, MD
- H. Christian Davidson, MD
- John L. Go, MD
- David S. Martin, MD
- Venkata Nataranjan, PhD
- Richard H. Wiggins, III, MD

Notes:

Notes:

NOTE ABOUT SCANNED IMAGES: Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2004.

Wednesday Morning

8:00 AM - 9:30 AM

Ballroom 6 A

(36) Perspectives on Submission of Grant Applications

(36a) Grantsmanship: The Art of Writing a Grant
— Colin P. Derdeyn, MD

(36b) The National Institutes of Health Review Process
— R. Nick Bryan, MD, PhD

(36c) Research Funding Opportunities for Neuroradiologists
— James M. Provenzale, MD

Moderator: James M. Provenzale, MD

Grantsmanship: The Art of Writing a Grant

Colin P. Derdeyn, MD

LEARNING OBJECTIVES

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

- 1) Explain and review the format and structure of grant applications
- 2) Define key points of emphasis in writing a grant
- 3) Discuss common critical mistakes made in preparing grant applications

PRESENTATION SUMMARY

Obtaining funding for research is a competitive process. The basic foundation for a competitive grant application was reviewed by previous speakers: the development of a testable hypothesis, the design of an experiment to adequately test the hypothesis, and the results of preliminary data indicating feasibility. No grant application lacking these fundamental items will be successful. Once you have assembled these items, your next two steps are to select a funding source and write a grant application. It is an unfortunate fact that many grant applications with great ideas, good design, and strong preliminary data fail simply because their authors

did not communicate effectively this information to the reviewers. The ability to write a good grant application is a specialized skill that investigators learn and develop over time. This skill in packaging has been called grantsmanship. This talk will focus on the key aspects of grant composition. First, we will discuss targeting the application for specific funding mechanisms - NIH RO1, R21, for example. Then we will use the current National Institutes of Health PHS 398 application form as a template and go through it page by page, emphasizing key points and common pitfalls. Case examples from successful and unsuccessful grant applications will be used to illustrate these points and pitfalls.

The National Institutes of Health Review Process

R. Nick Bryan, MD, PhD

LEARNING OBJECTIVES

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

- 1) Define and discuss the National Institutes of Health (NIH) structure
- 2) Review the Center for Scientific Review process
- 3) Describe a R01 Grant "Case Presentation" experience

PRESENTATION SUMMARY

The NIH utilizes a highly structured peer-review process for evaluating, funding, and monitoring its extramural grants. It is important to understand the system and follow its procedures closely as deviations from protocol can result in rejection of an application. While the system is stringent, it can be very helpful and it is fair. All NIH policies and practices are available on the WEB and the peer review process is well documented at: <http://www.csr.nih.gov/review/peerrev.htm>. A typical grant (R01/R21) is initially received by the Center for Scientific Review (CSR) and, using written guidelines, is assigned by a Referral Officer to an Integrated Review Group (IRG). IRGs are clusters of Study Sections that review similar science. The grant is then assigned to a specific Study Section and specific Institutes are identified that might be suitable for funding such a grant. Referral Officers do take into account written requests for specific IRG and Study Section assignments. A Study Section has approximately 20 members who are active researchers in the particular area of research covered by the Section. The Principle Investigator is notified of the assignment and further communication is between the PI and the Scientific Review Administrator (SRA) of that Study Section. The SRA reviews the grant for content, completion, etc and assigns it to 2 or 3 members of the Study Section for written review and 1 or 2 additional members for discussion. Submission of Supplementary Material to the original grant may be arranged between the SRA and PI. Each assigned reviewer provides the SRA a detailed written evaluation of the grant and a score based on a 100 to 500 point system (100 being best possible). Approximately a week before the Study Section meets, the SRA compiles all scores and those grants

that score in the lower half are "streamlined." These grants are not scored or discussed at the meeting and will not be funded; however the PI is given the written critiques and subsequently may revise and resubmit the grant. A Study Section meeting lasts 2 days, during which the members sit around a large table and review in detail all those grants not "streamlined." After active discussion of a grant, every member of the Study Section privately marks his/her Priority Score on a form provided by the SRA. After the meeting, a computer-generated average Priority Score and percentile is calculated and this, along with the written critique, is sent to the PI. These scores are also sent to the individual Institutes that select, on the basis of these scores and institutional priorities and resources, those grants to fund. At this point the applicant's link to the NIH changes from the SRA and CSR to an official of the particular Institute to which the grant has been assigned. For institutional funding, grants are usually well within the top quartile. Unfunded grants can be resubmitted. In fact this might be considered the norm for first time submissions, as many grants are initially rejected for funding. Hence it is very important to not be discouraged by an initial rejection; however resubmissions should carefully address concerns raised in the written critiques from the original Study Section.

Research Funding Opportunities for Neuroradiologists

James M. Provenzale, MD

LEARNING OBJECTIVES

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

- 1) Demonstrate to radiologists the categories of funding available through NIH
- 2) Explain the various types of government and private funding mechanisms available for research projects

PRESENTATION SUMMARY

Advances in diagnostic and therapeutic neuroradiology have led to greater stature of neuroradiologists in the medical community. Clinicians and researchers in other disciplines rely heavily on the expertise and imaging tools available to neuroradiologists. However, with increasing clinical demands, less time is available for neuroradiologists themselves to perform research studies. This lecture is a first step in an attempt to reverse this trend. Extramural funding is one means of insuring protected research time. Levels of available funding are reported to be at their highest level ever. The purpose of this lecture is to familiarize neuroradiologists with (1) a few of the tools needed to write successful research protocols and (2) some funding mechanisms that could provide funded research time needed for writing grant applications. A wide variety of funding mechanisms are available to radiologists. These mechanisms include federally funded resources, private foundations (e.g., NER Foundation and RSNA Research and Education Fund) and for-profit agencies such as industry. This lecture will focus on federally funded mechanisms that might be of interest to young investigators. In particular, The NIH K-series awards will be discussed in detail. This series of awards provide funding for 3-5 years for young researchers with potential to become independent investigators. They require mentorship by a more senior researcher in the young investigator's field or other scientific fields and generally require between 50%

and 75% effort by the young investigator. In addition, the R21 funding mechanism, which is for a maximum of 2 years and provide direct costs for the 2-year period not to exceed \$275,000, will be discussed. This funding mechanism is one that allows for investigation of exploratory hypotheses with little preliminary data. As such, it may provide young investigators with a means of obtaining funding that will allow them to obtain preliminary data needed for submission of grant applications, such as the R01 grant, that provide funding for a longer period.

Disclosure: The author of this presentation has indicated an affiliation with Philips Medical Systems: Research grant.

Wednesday Morning

8:00 AM - 9:30 AM

Ballroom 6 B/C

(37) Special Session: Can the Present Practice of Neuroradiology Survive? Meeting the Challenges of Marginalization and Change

(37a) Introduction

— *Victor M. Haughton, MD*

(37b) The End of One Time Certification

— *Patricia A. Hudgins, MD*

(37c) The R word?

— *Robert I. Grossman, MD*

(37d) Reimbursement Rates for Neuroradiology Procedures

— *J. Arliss Pollock, MD*

(37e) The Role of the Society in the Facilitation of the Neuroradiology Practice

— *A. James Barkovich, MD*

Moderator: *Victor M. Haughton, MD*

Introduction

Victor M. Haughton, MD

The End of One Time Certification

Patricia A. Hudgins, MD

What Procedures Will Be Reimbursed?

Robert I. Grossman, MD

Reimbursement Rates for Neuroradiology Procedures

J. Arliss Pollock, MD

The Role of the Society in the Facilitation of the Neuroradiology Practice

A. James Barkovich, MD

Wednesday Morning

8:00 AM - 9:30 AM
Room 602 - 603

(38) ELC Workshop D: Website
 Creation for the Novice

— *Richard H. Wiggins, III, MD*

Wednesday Morning

10:00 AM - 10:15 AM
Ballroom 6 B/C

(39) ASNR Presidential Address

— *Charles M. Strother, MD, ASNR President*

Wednesday Morning

10:15 AM - 11:10 AM
Ballroom 6 B/C

(40) ASNR Awards Presentation

(40a) Presentation of Gold Medal Awards

Moderators: *Charles M. Strother, MD,*
ASNR President
Victor M. Haughton, MD, Chair,
Gold Medal Awards Committee

(40b) Announcement of 2004 ASNR Honorary
 Member

Moderator: *Norman E. Leeds, MD, Chair,*
Honorary Member Committee

(40c) Presentation of 2004 Cornelius G. Dyke
 Memorial Award

Moderators: *Charles M. Strother, MD,*
ASNR President
Victor M. Haughton, MD,
ASNR President-Elect/Program Chair

(40d) Announcement of 2003 Outstanding
 Presentation Awards

Moderator: *Laurie A. Loevner, MD, Chair*
Education Committee

(40e) Announcement of Neuroradiology Education
 and Research (NER) Foundation Award for
 Outstanding Contributions in Research

Moderator: *A. James Barkovich, MD, Chair*
Neuroradiology Education and
Research Foundation

Announcement of 2004 Neuroradiology
 Education and Research (NER) Foundation
 Scholar Award in Neuroradiology Research

Announcement of 2004 Neuroradiology
 Education and Research (NER)
 Foundation/Boston Scientific Fellowship in
 Cerebrovascular Disease Research

Announcement of 2004
 Berlex/Neuroradiology Education and
 Research Foundation (NER) Fellowship in
 Basic Science Research Awards

Moderator: *James M. Provenzale, MD, Chair*
Research Committee

Wednesday

Wednesday Morning

11:10 AM - 11:15 AM

Ballroom 6 B/C

(41) Announcement of Symposium
Neuroradiologicum (SNR) XVIII,
Scientific Meeting of the World
Federation of Neuroradiological
Societies (WFNRS)

—Michael S. Huckman, MD, WFNRS President

Wednesday Morning

11:15 AM - 11:45 AM

Ballroom 6 B/C

(42) American Society of
Neuroradiology (ASNR) Annual
Business Meeting (Members Only)

Wednesday Afternoon

1:00 PM - 2:30 PM

Ballroom 6 B/C

(43) New Imaging Techniques in Spine
(ASSR)

(43a) New Imaging Techniques in Conventional
MR Imaging

—Lawrence N. Tanenbaum, MD

(43b) Diffusion Imaging in the Spine

—Gordon K. Sze, MD

(43c) Functional MR Imaging in the Spine

—Patrick W. Stroman, PhD

(43d) Magnetization Transfer in the Spine

—Massimo Filippi, MD

(43e) American Society of Spine Radiology (ASSR)
2004 Mentor Award: Prospective Analysis of
Clinical Outcomes After Percutaneous
Vertebroplasty for Painful Osteoporotic
Vertebral Body Fractures

—Huy M. Do, MD

Moderators: Gordon K. Sze, MD
Brian C. Bowen, MD, PhD

New Imaging Techniques in Conventional MR Imaging

Lawrence N. Tanenbaum, MD

Diffusion Imaging of the Spine

Gordon K. Sze, MD

LEARNING OBJECTIVES

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

- 1) Discuss the different methods of diffusion-weighted imaging that can be used in the spine
- 2) Delineate potential uses of diffusion-weighted imaging to different spine pathologies and to suggest the utility of different diffusion techniques to the evaluation of specific entities

PRESENTATION SUMMARY

Although still a technique undergoing a great deal of evolution, diffusion imaging has become increasingly applicable to the spine. At this point, diffusion-weighted imaging can be accomplished by several methods. These include single-shot echo-planar diffusion-weighted imaging which is the most widely available, single-shot fast spin-echo, navigator echo pulses, which generally are combined with the previous methods and line scan diffusion-weighted imaging. Single-shot echo-planar imaging, such as is used in the brain, can be, with some minor alterations of the sequences, applied to the spine. Reduction of the strength of the diffusion gradients is useful. In adults, the most common types of diffusion-weighted imaging suffer from excessive magnetic susceptibility artifact in the spine. In young pediatric patients, there is less magnetic susceptibility in the bony spine but susceptibility artifacts are still a problem due to the hematopoietic marrow. However, if evaluation of the cord is sought, this technique is still useful and widely available. Navigator echo pulses produce phase shift information due to bulk motion. They are used often with multishot spin-echo echo-planar imaging. When compared to single-shot techniques, better spatial resolution and less off-resonance effects are seen. There are also nonecho planar techniques, such as steady state free precession or single-shot fast spin-echo techniques, which can be combined with diffusion images. Single-shot fast spin-echo sequences use a 180° refocusing pulse and thus are less sensitive to magnetic susceptibility artifacts. Because of this, they are most useful in the evaluation of vertebral, rather than cord, lesions. These techniques have the advantage of minimizing susceptibility artifacts, and are more successful in examining the bony spine. They have been used primarily for looking at the possibility of differentiating nonosteoporotic compression fractures from tumor metastases. These techniques also can be combined with navigator echoes, which use an extra spin-echo sequence with no spatial phase encoding to provide phase shift information due to bulk motion. Finally, line scan diffusion imaging is a particularly useful technique which can be applied to the spine. This is a spin-echo-based technique that acquires data from individually excited columns or lines. Because no phase encoding gradients are used, artifacts due to motion are minimized. Magnetic susceptibility artifact also is reduced. The signal-to-noise ratio, however, can be decreased since data are received from one line rather than an entire slice. Multiple applications of diffusion imaging exist. Diffusion-weighted imaging has been most useful, and perhaps most controversial, in differentiating the osteoporotic compression fracture from malignant metastatic fracture. While further investigations should be performed using different diffusion techniques, it does seem to have some role in this clinical situation. Other specific lesions can be characterized better with diffusion. Epidermoids and dermoids can occur in the spinal canal. As in the brain, diffusion imaging is superb at differentiating these lesions from arachnoid cysts, loculations of cerebrospinal fluid caused by adhesions, or other lesions, such as cystic schwannomas, that may appear similar on conventional imaging. Similarly, diffusion imaging can be useful in cord lesions. These include cord infarction and myelitis. The MR appearance of these lesions can be nonspecific with conventional imaging; diffusion can help to delineate the underlying etiology.

Functional MR Imaging in the Spine

Patrick W. Stroman, PhD

Dr. Patrick Stroman is originally from British Columbia, Canada, and completed his B.Sc. (Honors) in Physics at the University of Victoria. Under the supervision of Drs. Peter Allen and Paul Man he obtained his Ph.D. in Applied Sciences in Medicine from the University of Alberta in Edmonton. His thesis topic was the measurement of lung fluid clearance by means of MR imaging and relaxometry. Dr. Stroman then worked as a postdoctoral fellow for 4 years in Quebec City, at the Quebec Biomaterials Institute and Laval University, using MR to investigate the interactions between tissues and implanted biomaterials. In 1997 he moved on to Winnipeg, Manitoba and joined the National Research Council of Canada at the Institute for Biodiagnostics, and began working on functional magnetic resonance imaging (fMRI), with a focus on spinal fMRI. In March 2004, Dr. Stroman will move to Queen's University in Kingston, Ontario where he will take a position as an Associate Professor in the Department of Diagnostic Radiology, with an Adjunct appointment in the Department of Physics, and will be the Director of the new fMRI Facility in the Center for Neuroscience Studies.

LEARNING OBJECTIVES

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

- 1) List basic spinal fMRI methods
- 2) Assess results obtained with spinal fMRI
- 3) Examine the practical applications of spinal fMRI

PRESENTATION SUMMARY

The methods and application of functional MR imaging (fMRI) for detecting neuronal activity in the spinal cord, will be presented. The development of spinal fMRI as an adaptation from conventional fMRI of the brain, and the verification that spinal fMRI demonstrates neuronal activity in the spinal cord, will be addressed briefly. The method has been developed over the past 6 years and has been verified, but has not been used yet as a clinical tool (1-4). Important aspects of how neuronal activity is detected with spinal fMRI, and how it differs from that in the brain, will be presented for the purposes of accurate interpretation of spinal fMRI results. New developments in the spinal fMRI method for obtaining large volume coverage, high resolution in three dimensions, and results displayed in any slice orientation also will be demonstrated. Examples of results from research subjects with complete and incomplete injuries, and with multiple sclerosis, will be presented to demonstrate the clinical and research potential of this tool. Finally, the practical aspects will be described of how spinal fMRI can be implemented on most clinical MR systems, without the need for adaptation or special equipment. Data analysis methods and interpretation of the results also will be described, with a view to how spinal fMRI can be implemented as a clinical tool.

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Magnetization Transfer in the Spine

Massimo Filippi, MD

Massimo Filippi was born in 1961, and graduated in Medicine in 1986 and received his Post-graduate degree in Neurology in 1990. His research activity has always been focused on the use of MR-based technology to improve our understanding of how neurologic diseases determine progressive accumulation of irreversible physical disability and cognitive impairment. Dr. Filippi is a member of various scientific societies and, in some of them, he has covered or is currently covering institutional roles. He has coordinated the MR acquisition and analysis of several large-scale international trials of MS. He is currently a member of the Editorial Boards of the *AJNR*, the *JNNP*, *Magnetic Resonance Imaging* and *Multiple Sclerosis* and also acts as a reviewer on a regular basis for several international scientific journals in the fields of neurology and neuroradiology. Dr. Filippi is author or co-author of more than 350 papers on peer-reviewed and indexed journals. Dr. Filippi recently was awarded the "Rita Levi Montalcini" Prize for his outstanding contributions to the application of MR techniques to the study of MS. Dr. Filippi is currently Head of the Neuroimaging Research Unit, Department of Neuroscience, Scientific Institute and University Ospedale San Raffaele, Milan, Italy.

LEARNING OBJECTIVES

Upon completion of session, participants will be able to:

- 1) Define the role of cervical cord MT imaging in the assessment of various neurological conditions
- 2) Define the role of cervical cord damage in the development of disability in multiple sclerosis

PRESENTATION SUMMARY

The cord is a clinically eloquent region, whose damage has the potential to influence significantly the functional outcome of many neurologic conditions. As a consequence, the application of MT MR imaging to the assessment of tissue damage in the cervical cord (CC) is likely to increase our understanding of the mechanisms leading to the development of neurologic irreversible disability. In multiple sclerosis (MS), CC damage has been studied recently in a group of 96 patients with different MS phenotypes, using MT ratio (MTR) histogram analysis (1). Multiple sclerosis patients

had significantly lower average MTR of the overall CC tissue than control subjects. Patients with relapsing-remitting (RR) MS had normal CC MTR histogram-derived metrics, whereas those with primary progressive (PP) MS had significantly lower average MTR and peak height. Patients with secondary progressive (SP) MS had lower MTR histogram peak height than those with RRMS. MTR histogram-derived metrics were independent predictors of locomotor disability. Another large study, where CC MTR histograms of 91 PPMS patients were compared to those of 36 SPMS patients, found no significant difference between these two groups (2). In PPMS, a model including CC area and MTR histogram peak height was significantly, albeit modestly, associated with the level of disability. In MS, only a moderate correlation has been found between average brain MTR and CC MTR (3), suggesting that CC damage in MS is not a mere reflection of brain pathology. Interestingly, the extent of CC damage (measured using MT MR imaging) has been found to be strictly associated with the extent of movement-associated cortical activations (measured using fMRI) in patients with cord demyelination (4). CC MTR was found to be normal in patients with migraine (5) and CADASIL (6) whereas significant CC MTR histogram changes have been found in patients with Devic's neuromyelitis optica (DNO) (7). Quantifying CC pathology using MTR is likely to increase the magnitude of clinical/MR correlations in neurologic conditions. However, due to the complexity of some of these conditions (e.g., MS), a multiparametric assessment of CC damage might be more informative. A recent diffusion tensor MR study of the brain and CC of 45 patients with MS indeed has shown a strong correlation between disability and a composite MR score based on average fractional anisotropy of the CC and average mean diffusivity of the brain.

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Prospective Analysis of Clinical Outcomes After Percutaneous Vertebroplasty for Painful Osteoporotic Vertebral Body Fractures

Huy M. Do, MD

PURPOSE

Previous studies have retrospectively evaluated the beneficial effects of percutaneous vertebroplasty. The purpose of our study is to prospectively evaluate the beneficial effects of percutaneous vertebroplasty on mobility, analgesic use and pain scale for patients with painful osteoporotic vertebral compression fractures that are refractory to medical therapy. Our study also aims to evaluate the short and long-term health benefits of percutaneous vertebroplasty using the SF-36 survey health scales.

MATERIALS AND METHODS

We prospectively followed 167 patients treated with 210 vertebroplasties between August 1999 and January 2003. The average age of patients was 74.6 years with a standard deviation of 12.2 years and 75% of the patients were women. Pre-procedural measurements of pain, mobility and analgesic use were compared with post-procedural measurements of these same scales one month after the procedure. Pre-procedural measurements of SF-36 health survey scales were also compared with post-procedural measurements one month and six months to three years after the procedure.

RESULTS

Pre-treatment pain score average was 8.71 with SE of 0.1, while post-treatment pain score average was 2.77 with SE of 0.18 ($p < 0.00001$). Pre-treatment analgesic use average was 2.93 with SE of 0.9, while post-treatment analgesic use average was 1.64 with SE of 0.09 ($p < 0.00001$). Pre-treatment activity level average was 2.66 with SE of 0.1, while post-treatment activity level average was 1.46 with SE of 0.11 ($p < 0.00001$). There was a statistically significant improvement ($p < 0.001$) on nine out of ten SF-36 health scales at one-month follow-up and a statistically significant improvement ($p < 0.02$) on eight out of ten SF-36 health scales at six month or longer-term follow-up.

CONCLUSION

Percutaneous vertebroplasty offers tremendous and statistically significant benefits in decreasing pain, decreasing use of analgesics and increasing mobility in appropriately selected patients. Percutaneous vertebroplasty also offers a statistically significant benefit in most SF-36 health scales at both short and long term follow-up.

This paper was selected to receive the American Society of Spine Radiology (ASSR) 2004 Mentor Award.

Wednesday Afternoon

1:00 PM - 2:30 PM

Ballroom 6 A

(43A) NeuroNews: Developing Research and Emerging Trends

Moderator: Victor M. Haughton, MD

Wednesday Afternoon

1:30 PM - 2:30 PM

Room 602 - 603

(43B) National Library of Medicine (NLM): PUBMED®/MEDLINE: Advanced Tips and Tricks Hands-on Workshop

—Linda Milgrom

Wednesday Afternoon

3:00 PM - 4:30 PM

Ballroom 6 B/C

(44a) Adult Brain: Vascular Imaging in Tumor and Ischemia
(Scientific Papers 190 - 200)

See also Parallel Sessions

(44b) Spine: Spinal Injections/Vertebroplasty

(44c) Adult Brain: Functional Imaging (fMRI, MSI, MRS, PET)

(44d) Spine: Trauma and Intervention

Moderators: Colin P. Derdeyn, MD
Timothy P.L. Roberts, PhD

Wednesday

Paper 190 Starting at 3:00 PM, Ending at 3:08 PM**Perfusion CT of Brain Tumors Including Blood-Brain Barrier Imaging**

Schramm, P.¹ • Klotz, E.² • Tronnier, V.¹ • Sartor, K.¹ • Hartmann, M.¹

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PURPOSE

Deciding on the optimal therapeutic strategy for patients with intraaxial brain tumors depends largely on the histopathologic findings of stereotactic brain biopsy. The determination of the target point is often based on lesion contrast-media enhancement in stereotactic CT. We included perfusion CT with blood-brain barrier (BBB) imaging into the prebiopsy planning process. The aim of our study was to investigate to which extent this method can be used for the differential diagnosis of brain tumors and if it has potential to provide better targeting information than simple lesion enhancement.

MATERIALS & METHODS

Thirty-eight patients evaluated or planned for a stereotactic biopsy because of intraaxial brain tumors or tumor-like lesions were examined with a standard 40 second perfusion CT scan after the injection of 50 ml of iodinated contrast media (300 mg Iodine/ml). Two 10 mm sections were acquired simultaneously on a multislice CT-scanner (SOMATOM Volume Zoom, Siemens, Germany). In 27 examinations the patient was scanned with the stereotactic ring. Data were analyzed using perfusion CT software which in addition to CBF and CBV maps allowed to calculate permeability maps depicting BBB disturbances. These maps were calculated using a modified Patlak approach. CBV and permeability maps were analyzed visually and compared with the final histopathologic findings.

RESULTS

Of the 38 patients examined 19 had glioblastoma (WHO IV) or anaplastic glioma (WHO III). In all of them we found significant BBB disturbances with hypervascularization. In glioblastoma the BBB disturbance was usually rim-like. Six patients had intracerebral lymphoma with substantial focal high BBB disturbance but normal CBV or only moderate hypervascularization. Seven patients had low-grade astrocytoma (WHO II) without BBB disturbance or even hypervascularization. Four patients had intracerebral metastasis, 1 patient had encephalitis, 1 had PML. Evaluation time per case was less than 5 minutes.

CONCLUSION

Perfusion CT including BBB imaging allows reliable discrimination of different brain tumor types based on their respective pattern of CBV and permeability, which agree very well with the histopathologic diagnosis. The method is fast and possible under stereotactic conditions. It can be used for differential diagnosis and may help to improve the target point selection in stereotactic biopsy with the potential to reduce the number of nonspecific biopsy findings.

KEY WORDS: Brain tumors, perfusion CT, blood-brain barrier imaging

The authors of this work have indicated the following affiliations/disclosures: Siemens Medical Solutions CTC AP; Employee.

Paper 191 Starting at 3:08 PM, Ending at 3:16 PM**Metabolic Assessment of Extent of Disease in Gliomas Utilizing High Resolution 3 T MR Spectroscopy**

Appignani, B. • Wong, E. T. • Wu, J. • Lenkinski, R.

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PURPOSE

To determine whether metabolic data from high resolution 3 T MR single and multivoxel two-dimensional (2D) MR spectroscopy (MRS) provides diagnostic information about the viability and extent of gliomas. Currently, evaluation of primary brain tumors is based primarily on assessment of abnormalities observed on T2- and gadolinium-enhanced T1-weighted MR imaging.

MATERIALS & METHODS

Twenty-eight patients with gliomas were studied on a GE 3 T MR scanner, both prior to and during treatment. There were four grade I, 16 intermediate (grade II-III), and 8 glioblastoma multiforme (grade IV) gliomas. 3 T examinations included 3 mm dual-echo T2-weighted scans, FLAIR, GRE, T1-weighted images volumetrically acquired before and following injection of 20 ml gadopentetate dimeglumine. A PRESS sequence with TR = 2000/TE = 35 msec, FOV = 24 cm, 1cm slice thickness and 16 x 16 phase encoding steps was utilized for spectroscopic imaging. Evaluation was based on the relative amounts of choline (Cho), creatine (Cr), N-acetylaspartate (NAA), lipid/lactate, and myoinositol (MI) in the spectra and on measurements of choline-to-creatine (Cho/Cr) ratios. An array of 4 pixel spectral samples was obtained in and around tumors and tumor resection/treatment sites (overlaid on T2 and gadolinium-enhanced images), with a sample in the 2D region of interest including "normal appearing" brain. Though single-voxel MRS was utilized to evaluate smaller or distant components of some tumors, 2D MRS enabled us to scan throughout tumor and surrounding tissue, which is the critical application of this technique.

RESULTS

All tumors exhibited metabolic abnormalities that extended beyond their anatomically visible borders. Spectral abnormalities of enhancing tumors did not conform to the enhancing region or treatment site "margins" and were detectable in areas without signal or morphologic abnormality in tumor treatment regions. Nonenhancing tumors or nonenhancing regions of tumors also displayed spectral abnormalities. In grade I and II gliomas, increases in choline and decreases in NAA were observed, along with elevations in MI peaks. No tumors of the lowest grade exhibited Cho/Cr ratios > 2, but elevation of the Cho/Cr ratio correlated with tumor grade. Intermediate and high-grade tumors that showed signs of growth also demonstrated progressively larger areas of spectral abnormality over time. Areas of T2 signal abnormality, which could be mistaken for vasogenic edema, occasionally displayed unusually high elevations in choline. In grade IV gliomas there were greater deviations from the normal spectral pattern and often marked elevations in lipid/lactate peaks both in necrotic-appearing treated regions of the tumor and in other locations of solid-appearing tumor.

CONCLUSION

It is clear that anatomical margins of tumors typically used to measure tumor extent or progression fall short of defining the actual disease identifiable based on metabolic measurements. Metabolic alterations in and around brain tumors identify larger areas of abnormal brain than do standard measures of tumor extent (1). This may have implications for the approaches taken to tumor treatment (2). Moreover, recognition of disease progression may first be appreciated by metabolic, not anatomical alterations in the brain parenchyma.

REFERENCES

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KEY WORDS: Spectroscopy, brain tumors, 3 T

Paper 192 Starting at 3:16 PM, Ending at 3:24 PM

Image Registration and Subtraction in the Detection of Marginal Changes in Tumor Volume

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PURPOSE

The major cause of mortality in patients with low-grade gliomas is their transformation to higher grade tumors. Low-grade gliomas generally are slow growing. There is evidence that an increase in the growth rate predicts subsequent transformation to a higher grade (1). The purpose of this study was to compare the ability of image registration and subtraction techniques to improve the detection of small changes in low-grade glioma volume when applied to standard T2 and FLAIR imaging protocols.

MATERIALS & METHODS

Tumor size was assessed on the basis of increased signal on T2-weighted and fluid attenuated inversion recovery (FLAIR) sequences. Thirteen patients were selected retrospectively with minimal or no change in tumor size reported after serial imaging. Forty-two pairs of imaging sequences acquired with standard clinical protocols were compared (27 pairs of T2-weighted sequences: TR = 3.2 s, TE = 72 ms, FOV = 22 cm, matrix = 256^2 , slice thickness = 5 mm, spacing = 2 mm; 15 pairs of FLAIR sequences: TR = 9 s, TE = 160 ms, TI = 2.2 s, matrix = 256^2 , slice thickness = 5 mm, spacing = 2 mm). Imaging was performed with 1.5 T GE Signa Horizon and LX scanners (GE Medical Systems, Milwaukee, WI). For each patient, the earliest T2 and FLAIR imaging studies available were used as baseline scans. Subsequent studies were registered to the baseline scan using a maximization of correlation technique (2, 3). Subtraction images were generated for each comparison and the images were assessed independently by three neuroradiologists using a nonparametric rating scale (-2: definite decrease in tumor size, -1: possible decrease, 0: no change, 1: possible increase, 2: definite increase) and analyzed by SPSS. An average rating for each comparison was obtained and interrater variability also was evaluated.

RESULTS

In 22 of the 42 comparisons the average tumor rating was upgraded after registration; in one it was downgraded, and in the remaining 19 the rating remained unchanged. There were statistically significant differences in the mean ratings between all registered vs unregistered images ($p = 0.001$, Wilcoxon signed ranks test), T2 and FLAIR registered/subtracted vs unregistered images ($p < 0.001$, Wilcoxon signed ranks test). For upgraded tumors the addition of subtraction increased the mean rating compared to registered images on FLAIR images. The reproducibility and kappa values were increased by registration and registration/subtraction images on FLAIR images but reduced on T2 images.

CONCLUSION

Registration and subtraction techniques can be applied successfully to images acquired with standard clinical protocols. Registration increases the detection of small changes in tumor volume. Subtraction techniques may provide additional benefit when reviewing FLAIR images. Both registration and subtraction techniques are most sensitive and reproducible when FLAIR sequences are used.

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KEY WORDS: Low-grade glioma, MR imaging, registration, subtraction

Paper 193 Starting at 3:24 PM, Ending at 3:32 PM

Comparison of Lesional and Perilesional Cerebral Blood Volume and Vascular Permeability Measurements in Differentiating between Radiation Necrosis and Recurrent Glioma

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PURPOSE

To compare relative cerebral blood volume (rCBV) and vascular permeability (K^{trans}) measurements in the lesional and perilesional regions of radiation necrosis and recurrent high-grade gliomas. We hypothesize that the lesional and perilesional rCBV measurements are higher in recurrent gliomas compared with radiation necrosis, and that the lesional K^{trans} should be similar as both entities demonstrate blood-brain barrier disruption. We also postulate that the perilesional K^{trans} should be higher surrounding recurrent gliomas given the infiltrative nature of these high-grade lesions.

MATERIALS & METHODS

Twenty patients with previously documented intracranial tumors receiving radiotherapy underwent conventional MR imaging, and DSC MR imaging. Maximal rCBV measure-

ments were obtained from regions of contrast enhancement and maximal perfusion abnormality as determined from color overlay maps. Vascular permeability measurements derived simultaneously from a pharmacokinetic modeling algorithm also were obtained in all lesions. Measurements of rCBV and K^{trans} then were obtained in areas of T2 signal abnormality within the adjacent perilesional region without associated contrast enhancement. The data from these methodologies subsequently was compared to histopathology as determined from volumetric resection.

RESULTS

Nine patients were determined to have pathology compatible with radiation necrosis, while 11 patients studied were determined to have recurrent gliomas. Within the radiation necrosis group, rCBV was found to average 0.47 ± 0.42 , as compared to 7.20 ± 2.76 in the recurrent glioma group ($P < 0.001$). Within the perilesional region, rCBV averaged 0.77 ± 0.49 in the necrosis group, and 2.31 ± 1.09 in the recurrent glioma group ($P < 0.015$). No significant difference was found in lesional K^{trans} between the two groups ($3.33 \times 10^{-4} \pm 5.84 \times 10^{-4}$ vs $2.06 \times 10^{-3} \pm 4.87 \times 10^{-3}$) or perilesional K^{trans} ($5.27 \times 10^{-5} \pm 5.22 \times 10^{-5}$ vs $9.77 \times 10^{-4} \pm 2.00 \times 10^{-3}$), although permeability constants trended higher in the recurrent glioma groups in both the lesional and perilesional region.

CONCLUSION

Recurrent high-grade gliomas demonstrated significantly higher relative cerebral blood volume measurements in both the enhancing lesion as well as the perilesional T2 abnormality as compared to radiation necrosis. There was no significant difference found in the lesional or perilesional vascular permeability. Findings are consistent with the histologic findings of fibrinoid necrosis, endothelial thickening, and vascular obliteration in radiation necrosis, as well as the presence of blood-brain barrier disruption in both radiation necrosis and recurrent gliomas.

KEY WORDS: Radiation necrosis, cerebral blood volume, perfusion

Paper 194 Starting at 3:32 PM, Ending at 3:40 PM

CO2 Challenge CT Perfusion Imaging in Assessment of Cerebral Vascular Reserve: Review of Findings in Six Patients with Chronic Cerebral Ischemia

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PURPOSE

Diminished cerebrovascular reserve (CVR) is an independent risk factor for stroke (1). Among patients with chronic cerebrovascular insufficiency, knowledge of CVR may guide treatment choices (2). We hypothesized that CT perfusion with a CO2 challenge (CO2-CTP) could quantify cerebrovascular reserve.

MATERIALS & METHODS

We retrospectively reviewed CO2-CTP studies from 6 patients with symptomatic chronic cerebrovascular occlusion. Patients ranged in age from 31-65 years. Two had left

internal carotid occlusion, three had bilateral carotid occlusions, and one had moyamoya disease. Results from the CO2-CTP were compared to results from single photon emission tomography (SPECT) imaging with acetazolamide and/or transcranial Doppler (TCD) imaging with CO2 challenge. Each CO2-CTP study consisted of a baseline CT perfusion series followed by a second series while the patient inhaled 5% CO2 in air. End-expiratory PCO2 was recorded for both scans. The percentage change in cerebral blood flow (CBF) between the baseline and challenge scans was calculated and adjusted for the change in PCO2. Regions of interest (ROIs) were evaluated and compared to the SPECT and TCD results. The average of the hemisphere as well as ROIs were compared. We defined an abnormal CO2-CTP (equivalent to diminished CVR) if change in cerebral blood flow during hypercapnia was less than 2% per mmHg (3).

RESULTS

All patients had reduced CVR by all modalities. Comparison of CVR by hemispheres showed agreement between CO2-CTP and SPECT in 8/10 hemispheres and agreement between CO2-CTP and TCD in 6/8 hemispheres. Regional flow comparisons between CO2-CTP and SPECT agreed in 4 of the 5 patients who had both exams. In the patient with moyamoya, the average change in CBF in the hemisphere was normal (4%/mm Hg). However, regional change CBF in the anterior cerebral arteries was -3.8%/mm Hg on the right and 2.1%/mm Hg on the left. SPECT showed decreased ACA and watershed vascular reserve, R > L, while TCD showed greater impairment in the left MCA. In the second discordant case, with left carotid dissection and occlusion, impaired vascular reserve shown with SPECT and TCD was not reflected in the CO2-CTP.

CONCLUSION

CO2 challenge CTP is a promising method of quantifying CVR in patients with chronic cerebrovascular disease. Our preliminary results suggest CO2-CTP is comparable to SPECT with acetazolamide and CO2 challenge TCD. The discordance between CO2-CTP and SPECT may reflect the difference between acetazolamide and CO2 as vasodilatory agents. The TCD and CO2-CTP discordance may occur because TCD measures vascular velocity rather than CBF.

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KEY WORDS: CT perfusion, carotid occlusion

Paper 195 Starting at 3:40 PM, Ending at 3:48 PM**A CT Angiography-Based, Multivariable, “Benefit of Recanalization” Model for Acute Stroke Triage: Core Infarct Size on CT Angiography Source Images Independently Predicts Outcome**

Lev, M. H.¹ • Roccatagliata, L.¹ • Murphy, E. K.¹ • Coutts, S. B.² • Schaefer, P. W.¹ • Koroshetz, W. J.¹ • Demchuk, A. M.² • Gonzalez, R. G.¹ • Schwamm, L. H.¹

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PURPOSE

CT angiographic source images (CTA SI), like diffusion-weighted MR images (DWI), have been shown to predict final infarct volume (1). We sought to develop a multivariable, linear, CTA/CTA SI-based model for predicting final clinical outcome, in a population of acute stroke patients for whom definitive recanalization data were available.

MATERIALS & METHODS

Forty stroke patients were studied acutely using unenhanced CT followed by CTA with CTA SI. Of these, 19 had early, complete vascular recanalization (13 IA thrombolysis, 2 IV thrombolysis, 2 IV + IA, and 2 untreated), and 21 did not (16 IA thrombolysis, 1 IV thrombolysis, 2 IV + IA, and 2 untreated). Two senior raters graded all scans on a five-point scale for each of the following findings: (1) vessel occlusion score on CTA, (2) collateral circulation score on CTA, (3) ASPECTS score on unenhanced CT, (4) ASPECTS score on CTA SI, (5) motor strip lesion presence on CTA SI, and (6) CTA SI lesion volume (normal, >, or < 100 ml). These data, as well as admission NIH stroke scale (NIHSS) score and time-to-scan, were correlated with follow-up modified Rankin score (mRS) using a linear, multivariable model with stepwise regression.

RESULTS

The complete and incomplete recanalization groups, when compared, had similar mean admission NIHSS scores (18.4 vs 18.4) and time-to-scans (2.3 vs 2.0 hours), but different final mRS (1.9 vs 3.7). For the complete recanalization group, the only independent predictors of outcome were admission CTA SI lesion volume ($p = 0.001$, R-square 0.30) and time-to-scan ($p = 0.004$, R-square 0.39), for a model R-square of 0.69 (total model R-square 0.89). For the incomplete recanalization group, the only independent predictors of outcome were admission CTA SI lesion volume ($p = 0.0002$, R-square 0.47) and NIHSS score ($p = 0.018$, R-square 0.13), for a model R-square of 0.60 (total model R-square 0.85).

CONCLUSION

A relatively simple “stroke scale score,” based on admission (1) CTA SI lesion volume, (2) NIHSS score, and (3) time-to-scan, strongly predicts clinical outcome in acute stroke patients. Such a score may be of value for triage to therapy or clinical trials, by comparing the mRS to be expected for patients with, vs those without, early complete recanalization. For the complete recanalization group, CTA SI lesion volume and time-to-scan predicted outcome, because irreversible “core” infarct volume is a function of the duration and depth of ischemia. For the incomplete recanalization

group, time-to-scan was replaced by admission NIHSS score in outcome prediction, reflecting infarct growth into non-reperfused ischemic tissue. The NIHSS reflects the “territory at risk” (i.e., “penumbra”) responsible for the presenting clinical syndrome.

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KEY WORDS: Acute stroke, CTA

Paper 196 Starting at 3:48 PM, Ending at 3:56 PM**Assessment of the Dense Vessel Sign on Noncontrast Head CT Imaging: Evaluation of the Hyperdense Middle Cerebral Artery Sign by CT Angiography**

Mullins, M. E. • Schwamm, L. • Maqsood, M. • Abdullah, A. • Gonzalez, R. • Koroshetz, W. • Lev, M.

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PURPOSE

To determine the meaning of the noncontrast head CT hyperdense middle cerebral artery sign (HMCAS) as defined by CT angiography.

MATERIALS & METHODS

Forty-five consecutive emergency department patients were enrolled prospectively with symptoms of acute stroke for less than 6 hours' duration, receiving noncontrast head CT followed immediately by CT angiography. Source and 3D reformatted images were interpreted. Patients did not receive anticoagulation or thrombolysis therapy until after imaging. Clinical results were obtained prospectively. The images were reviewed retrospectively and consensus on results was obtained with only the stated history provided. Density was evaluated subjectively on a five point system. Comparison to CTA was performed via an eight point system comparing location and/or overlap of clot, if any, to the location of the dense vessel.

RESULTS

Twenty-six patients (26/45, 58%) had no perceived density within the M1 segment of the MCA on initial imaging, whereas 19 patients (19/45, 42%) did; including 6 equivocal (6/19, 32%), 5 probable (5/19, 26%), 6 definite (6/19, 32%) and 2 robust/very dense (2/19, 11%). When equivocal cases were excluded, 13 patients (13/45, 29%) had definite HMCAS; 5 patients (5/13, 38%) had one-to-one correspondence of clot to dense vessel but 8 patients (8/13, 62%) did not, including 3 (3/13, 23%) with partial overlap and dense vessel proximal to clot and 5 (5/13, 38%) with complete overlap with dense vessel smaller than clot (associated with ICA thrombosis and T-lesions).

CONCLUSION

When HCMAS was definite in this patient cohort, all 13 patients had arterial clot; however, in more than half of these cases, the dense vessel did not correspond in a one-to-one fashion to both clot location and size. Three groups emerged: (1) one-to-one correspondence in size and location of dense vessel to arterial clot, (2) complete overlap of dense vessel with arterial clot larger and extending proximally, and (3) partial overlap of dense vessel with arterial clot extending distally. These findings suggest that density noted on CT within the M1 segment is not universally a direct manifestation of intrinsic clot density; thus, HCMAS is likely due to one or a combination of pathophysiologic entities in addition to or instead of intrinsic density, including slow/stagnant flow and extrusion of plasma.

KEY WORDS: Stroke, dense MCA sign, CT angiography

Paper 197 Starting at 3:56 PM, Ending at 4:04 PM

Iron and Gadolinium as Imaging Agents in PCNSL and Other Central Nervous System “Inflammatory” Lesions

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PURPOSE

Superparamagnetic, lymphotropic ultra small iron oxides particles (USPIO) are used in MR imaging as contrast agents due to shortening of T1 and T2 relaxation time. Ferumoxatran-10 (Combidex®, Advanced Magnetix Inc., Cambridge, MA), a dextran-coated viral-sized iron particle has a long plasma life of 24-30 hours, resulting in prolonged and progressive accumulation in human intracranial lesions. The enhancement caused by iron-oxide accumulation was compared to standard gadolinium-enhanced baseline MR images, to assess the potential role of ferumoxatran-10 in different types of CNS lesions including lymphoma (PCNSL), multiple sclerosis (MS), and stroke.

MATERIALS & METHODS

Fifteen patients (9 female, 6 male, age between 24-77 years, average 48 years) were investigated with different types of intracranial hematopoietic tumor and/or “inflammatory” lesions. All of the patients had standard brain MR (1.5 T) imaging with and without gadolinium varying 1-29 days (average 10) before the iron scan. The dose of ferumoxatran-10 was 2.6 mg/kg, infused intravenously for half an hour. The ferumoxatran-10 MR study was made 24 hours after iron infusion and included SET1, FST2, and proton density (PD), GRE2*, and DWI.

RESULTS

In fifteen patients, eight different types of lesions were examined (7 MS, 3 stroke, 2 PCNSL, 1 acute disseminated encephalomyelitis, 1 myofibroblastic tumor, 1 inflammatory lesion, 1 meningioma, and 1 cavernoma). In five cases ferumoxatran-10 scan showed higher signal intensity and/or larger area of enhancement and/or new enhancing area(s) compared to gadolinium. Two MS, one stroke, and one PCNSL case did not show any enhancement with either gadolinium nor with ferumoxatran-10. Three MS patients

showed faint enhancement with gadolinium and no enhancement with ferumoxatran-10. The remaining five cases showed less enhancement with ferumoxatran-10 than gadolinium. Two patients were biopsied after ferumoxatran-10 infusion, and their tissue currently is being stained for iron for comparison with imaging studies. No toxicity due to ferumoxatran-10 was seen.

CONCLUSION

Ferumoxatran-10 vs gadolinium shows different size and location of lesions in PCNSL and other different type of CNS “inflammatory” lesions. In some cases ferumoxatran-10 and in other cases gadolinium showed better or more enhancement. It seems that in MS ferumoxatran-10 does not enhance as well as it does in other inflammatory lesions or tumors, which may mean a difference in blood-brain barrier leak size and/or intracellular trapping. Most MS lesions did not enhance with ferumoxatran-10 while most lymphomas and strokes did enhance which could help in differential diagnosis. Further study should be done to find out the utility of the new iron-oxide-based contrast agent.

KEY WORDS: Brain imaging, MR imaging, iron-oxide contrast

Paper 198 Starting at 4:04 PM, Ending at 4:12 PM

Diffusion-Weighted MR Imaging in the Follow-Up Assessment of Cerebral Abscesses Undergoing Therapy

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PURPOSE

Intracerebral abscess accounts for 2.5-5.0% of all intracranial mass lesions and their mortality ranges from 8% to as high as 89%. Data from recent studies suggest that diffusion-weighted imaging (DWI) is more sensitive in distinguishing between brain abscess and cystic tumors than conventional MR imaging. Pus in brain abscesses is strongly hyperintense on trace DWI and has reduced apparent diffusion coefficient (ADC); whereas most necrotic or cystic brain tumors have intermediate DWI signal and elevated ADC values. Surgically or conservatively treated brain abscesses may resolve or experience reaccumulation of pus requiring further intervention or treatment change. Our purpose was to evaluate the utility of DWI in the posttreatment follow-up of abscesses and to identify imaging features related to success or failure of therapy.

MATERIALS & METHODS

Conventional MR imaging including contrast-enhanced T1-, T2-imaging, and DWI were performed in 7 patients with proven pyogenic brain abscesses. Qualitative and quantitative analysis of the center of the abscess on DWI was performed on the initial studies and in all follow-up studies in all patients. ADC values were recorded from the baseline pretherapy studies and in all follow-up studies obtained during the treatment. We then correlated the signal intensity on trace DWI and the ADCs with the clinical and laboratory evaluations in particular with respect to treatment failure and reoperation. The findings in DWI and ADC maps were correlated also with those of MR imaging.

RESULTS

Patients age ranged from 30-69 years. Surgical drainage was performed in 6 patients, 1 patient was treated solely with antibiotics. All abscess cavities initially had high DWI signal (restricted diffusion) with a mean ADC value of $0.53 \times 10^{-3} \text{ mm}^2/\text{sec}$. Low DWI signal with high ADC were seen on follow-up scans in the patient who was on medication, and in 4 patients in whom the abscesses were drained and correlated with a good therapeutic response. Two patients underwent drainage and the first follow-up studies showed areas of high DWI signal and low ADC values suggesting reaccumulation of pus. In one of them, a second follow-up MR image showed mild increase in size and decrease ADC in multiple abscesses. Increase in inflammatory laboratory parameters correlated well with DWI findings. Reaccumulation of pus showed no specific or distinct features on conventional MR sequences except for mild enlargement of the cavities in one patient.

CONCLUSION

Our preliminary experience indicates that trace DWI and ADC maps are useful in the posttreatment follow-up of brain abscesses. A decreased signal intensity on trace DWI and increasing ADC values in the abscess cavity correlate with a successful treatment. Conversely, persistent or reappearance of high signal intensity within the abscess cavity on trace DWI and low ADC values indicating restricted diffusion are seen on treatment failure and correlate with pus reaccumulation. Findings between successfully and unsuccessfully treated brain abscess on conventional MR imaging were similar and did not allow for differentiation between these two groups, thus we believe that DWI may play an important role in the evaluation of the treated brain abscess.

KEY WORDS: Brain abscess, diffusion-weighted MR imaging, follow-up

Paper 199 Starting at 4:12 PM, Ending at 4:20 PM

Evaluation of Cerebral Blood Flow Dynamics with MR Perfusion-Weighted Imaging in High Flow Extracranial-Intracranial Saphenous Graft Bypass

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PURPOSE

The aim of this study was to assess the cerebral vascular hemodynamic in patients with high flow extracranial-intracranial (EC-IC) saphenous graft bypass performed for therapeutic occlusion of the internal carotid artery (ICA).

MATERIALS & METHODS

Sixteen patients with ICA occlusion and EC-IC bypass (15 for unclippable/uncoilable aneurysms and 1 for meningioma involving the ICA) with a time interval from surgery ranging from 6 months to 6 years, underwent MR examination. Standard SE sequences as well as perfusion-weighted sequences were performed (T2*-weighted echo-planar sequence, TR = 620 ms, TE = 30 ms, FA = 40°, matrix = 128 x 64, 40 dynamic series, n. of signals acquired 1, imaging time 1 min 22 sec, nine slices with a thickness of 7 mm, single dose 0.2 mmol/kg of gadolinium at the rate of 4 ml/sec).

Regional cerebral blood volume (rCBV), mean transit time (MTT) and regional cerebral blood flow (rCBF) were evaluated in all patients at the level of basal ganglia (BG), centrum semiovale (CS) and cortex (C) in both hemispheres.

RESULTS

Statistically significant differences ($p < .005$) were observed at the level of the BG and in the C indicating increased rCBV and MTT in the BG and decreased rCBF in the C of the hemisphere vascularized by the graft with respect to the contralateral.

CONCLUSION

Patients with occlusion of the ICA and high flow EC-IC bypass do have altered vascular hemodynamic status between the hemispheres. Our data seem to indicate that the increased MTT of the hemisphere supplied by the EC-IC is compensated by an increased rCBV (indicating vasodilatation) in the BG thus enabling normal rCBF in this region. On the other hand rCBF seems to be impaired in the surgical hemisphere at the level of the C. Even though it has been reported that high flow EC-IC bypass increases the vascular collateral reserve improving morbidity in patients undergoing therapeutic occlusion of the ICA, our data show that there still is some hemodynamic impairment in the surgical hemisphere. These patients should be followed up to rule out chronic ischemia.

KEY WORDS: EC-IC bypass, perfusion-weighted imaging, ICA

Paper 200 Starting at 4:20 PM, Ending at 4:28 PM

Basal Ganglion Neurodegeneration in Multiple Sclerosis Measured by Dynamic Susceptibility Contrast MR Imaging

Law, M. • Ge, Y. • Johnson, G. • Mannon, L. • Herbert, J. • Grossman, R. I.

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PURPOSE

The cerebral hemodynamics in multiple sclerosis (MS) have been poorly studied. In this study, we studied the microcirculation in the basal ganglionic gray matter in patients with relapsing remitting (RR) MS using dynamic susceptibility contrast MR (DSC MR) imaging, knowing that primary demyelination affects both gray and white matter. The purpose of this study was to determine if there is hemodynamic impairment in the basal ganglionic gray matter that is an important factor in neurodegeneration of MS patients.

MATERIALS & METHODS

Seventeen patients with clinical relapsing remitting MS were recruited for this study. Imaging was performed on a 1.5 T MR imager. Twelve controls also were selected for comparison. Absolute perfusion parameters for cerebral blood volume (CBV), cerebral blood flow (CBF), and mean transit time (MTT) were computed using an automated method for calculation of artery input function (AIF). Measurements were made in 2 subregions of putamen and thalamus in each hemisphere in patients and controls. The mean values for each perfusion parameter in each region were obtained for the analysis.

RESULTS

Dynamic susceptibility contrast MR imaging perfusion parameters of CBV, CBF, and MTT expressed as mean and standard deviation (SD) for putamen and thalamic gray matter in patient and control groups are summarized and compared in Table 1. All perfusion parameters (CBF, CBV, and MTT) in both putamen and thalamus showed a significant decrease in perfusion ($p \leq 0.01$) between patient and control groups, indicating there is a significant hypoperfusion in the gray matter of patients with MS.

Table 1: Measured parameters in thalamus and putamen for patients versus controls

Subjects	Thalamus			Putamen		
	CBF	CBV	MTT	CBF	CBV	MTT
MS	25.6±11.7	1.98±0.57	3.38±0.81	36.1±17.0	1.86±0.65	3.20±0.83
Control	65.9±14.8	3.80±1.01	2.90±0.55	87.9±15.4	4.24±0.74	2.68±0.45
P values	< 0.0001	< 0.0001	< 0.01	< 0.0001	< 0.0001	< 0.004

Note: CBF: (ml/100 g tissue/min); CBV (ml/100 g tissue); MTT: (seconds)

CONCLUSION

These results suggest that there is hemodynamic impairment in basal ganglionic gray matter in patients with MS and that measurements of cerebral perfusion using DSC MR imaging may be useful as an indicator of brain neurodegeneration in MS. Because cerebral blood flow is critical in maintaining the brain function and metabolism, further study will determine if hemodynamic impairment in the deep gray matter is a primary (i.e., ischemic pathogenesis from vascular inflammation/lymphocytic infiltration) or secondary event (i.e., reduced metabolic demand due to widespread parenchymal injury/reactive astrogliosis) in the disease.

KEY WORDS: Multiple sclerosis, perfusion, basal ganglion

Paper 201 Starting at 3:00 PM, Ending at 3:08 PM

Complications in Cervical Percutaneous Vertebroplasty for Spine Neoplasm

Barragán-Campos, H. M. • Vallee, J. • Lo, D. • Mont'Alverne, F. • Cormier, E. • Jean, B. • Rose, M. • Chiras, J.

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PURPOSE

To evaluate the complication's rate of cervical percutaneous vertebroplasty (CPV) performed with polymethylmethacrylate cement (PMMA) for treatment of cervical spine neoplasm (CSN).

MATERIALS & METHODS

Retrospective evaluation of 33 CPV performed in 21 patients, during a 2-year period (2001-2002). Information was recovered from the clinical record and included a post-procedure follow-up of 30 days; radiologic data included postprocedure standard X-ray, and CT images. The etiologies of CSN were classified as benign (hemangioma) and malignant neoplasm (metastasis or non-Hodgkin lymphoma), while complications were reported as local: hematoma, abscess, radiculopathy (RDC), vertebral disk leakage (VDL) and persistent pain; or systemic: pulmonary embolism (PE), septicemia, airway obstruction, respiratory failure, or shock.

RESULTS

Among the 33 sessions of CPV, local symptomatic complications were found in 1/33 (3.0%) procedures. This complication was a hematoma related to puncture site, 1/33 procedures (3.0%), no other complications were identified in our sample. Even when venous leakage (paraspinal plexus 2/33, 6.0%; epidural plexus 3/33, 9.0%), paraspinal soft tissue leakage 6/33 (18.2%), puncture tract leakage 5/33, (15.2%) and VDL 1/33, (3.0%) were identified all of them were asymptomatic, so they were considered as technical incidents. No systemic complication was detected in our series.

CONCLUSION

CPV using PMMA, alone or associated with other therapies, has been proved as an efficient treatment for pain management in CSN. Symptomatic complication's rate in CPV is low (3.0%). In the postoperative period the only local complications was resolved spontaneously. At 1-month evolution, no local symptom was related to VDL. No systemic complication was detected in our series; however the neuro-radiologist should be cautious and remember that a cervical compressive hematoma is still the most dangerous complication in this type of procedure.

KEY WORDS: Vertebroplasty, cervical spine neoplasm, complications

Wednesday Afternoon

3:00 PM - 4:30 PM
Ballroom 6 A

**(44b) Spine: Spinal
Injections/Vertebroplasty
(Scientific Papers 201- 211)**

See also Parallel Sessions

(44a) Adult Brain: Vascular Imaging in Tumor and Ischemia

(44c) Adult Brain: Functional Imaging (fMRI, MSI, MRS, PET)

(44d) Spine: Trauma and Intervention

Moderators : Wade H.M. Wong, DO
Alyssa T. Watanabe, MD

Paper 202 Starting at 3:08 PM, Ending at 3:16 PM**Correlation of Pretreatment MR Imaging and Clinical Outcomes in Patients with Osteoporotic Vertebral Body Compression Fractures Treated with Percutaneous Vertebroplasty**

Do, H. M. • Arakawa, H. • Curtis, L. • Jayaraman, M. • Marks, M.

Stanford University
Stanford, CA

PURPOSE

To assess the accuracy of MR imaging signal changes in predicting the clinical outcomes of patients with vertebral compression fractures (VCFs) who were treated with percutaneous vertebroplasty (PV).

MATERIALS & METHODS

Thirty-four patients with 37 painful osteoporotic VCFs were reviewed. All patients had pretreatment MR imaging consisting of T1-weighted, T2-weighted, and STIR sequences. MR signal intensities within the target vertebra were compared with adjacent normal appearing vertebrae. Pain relief was assessed by comparing the pretreatment and 30 day posttreatment pain scores using the visual analog scale (VAS) and correlated with MR signal changes. The sensitivities, specificities, positive and negative predictive values for each MR sequence were calculated using Fisher's exact test. Our hypothesis is that patients with VCFs exhibiting MR signal changes consistent with vertebral bone marrow edema (T1 hypointensity, T2, and STIR hyperintensity) are most likely to experience pain relief with PV treatment.

RESULTS

Thirty of 37 treatments (81%) resulted in either full (24/37, 65%) or partial (6/37, 16%) pain relief; full pain relief means a VAS of zero and partial pain relief means a lower VAS after treatment than before treatment. Seven treatments (7/37, 19%) did not result in pain relief. No patients experienced worsening pain after treatment and there were no treatment-related complications. We found no statistically significant value of MR imaging in predicting clinical pain relief. When assessing each sequence individually, 87.5% of patients with T1 hypointensity improved with PV compared with 75% of patients with T1 iso/hyperintensity. Seventy-five percent of patients with T2 hyperintensity improved with PV compared with 85% of patients with T2 iso/hypointensity. Patients (82.4%) with STIR hyperintensity improved with PV compared with 100% of patients with STIR isointensity. The sensitivities and specificities of T1 hypointensity, T2 hyperintensity, and STIR hyperintensity for any clinical improvement are 70%/50%, 41%/4%/42.9%, and 77.8%/0%, respectively. There was no improvement in these values when the MR sequences were assessed in combination.

CONCLUSION

Proper patient selection is an important factor to achieve better clinical outcome for patients evaluated for possible PV treatment. This evaluation usually consists of detailed history, physical examination, and review of imaging studies (X-rays, MR images, CTs, and bone scans). However this study does not support the notion that MR findings of bone marrow edema would be predictive of clinical improvement for patients with symptomatic VCFs treated with PV.

KEY WORDS: Vertebroplasty, MR imaging, clinical outcomes

Paper 203 Starting at 3:16 PM, Ending at 3:24 PM**Biopsy Results in Percutaneous Vertebroplasty: Correlation with MR Findings**

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PURPOSE

The significance of contrast enhancement on MR imaging in compressed vertebral body fractures is not well documented in the literature. The purpose of this study is to evaluate the histologic findings in intraoperative biopsy during percutaneous vertebroplasty (PVP) and to correlate with the MR findings.

MATERIALS & METHODS

Percutaneous vertebroplasty was performed for 39 vertebral bodies in 34 consecutive patients. Preprocedural MR imaging (1.5 T) was obtained in all patients. The MR sequence included T1-, T2-weighted sagittal images and contrast-enhanced study with fat suppressed technique. Twenty-eight patients had osteoporotic compression fractures and 47 biopsies were performed in 31 vertebral bodies prior to PVP. Six patients had metastatic tumors clinically and radiologically, and 13 biopsies were performed among 24 vertebral bodies. All biopsies were performed using 18 gauge biopsy needles with a spring-loaded gun coaxially through 11 or 13 gauge needles which were used for PVP. Biopsy needles were placed in the areas with contrast enhancement on MR imaging but in 7 cases, the needles had to be placed in unenhanced areas for optimal cement injection.

RESULTS

1. Osteoporotic compression fractures: Among 47 vertebral biopsy sites, diffuse homogeneous contrast enhancements were noted in 12. The pathologic findings of these 12 revealed granulation in 7, fibrosis in 3, and edema in 2. There were 28 biopsy sites in which MR imaging showed heterogeneous or patchy contrast enhancement. Their pathologic findings showed fibrosis in 11, normal bone marrow in 11, granulation in 2, necrosis in 2, degeneration in one, and undetermined in one. Seven biopsy sites from the area with no contrast enhancement showed necrosis in 3, degeneration in 3 and nondiagnostic in one. 2. Metastatic tumors: Thirteen biopsy specimens were obtained and 8 showed positive histologic confirmation. The other 5 showed normal bone marrow or nondiagnostic.

CONCLUSION

The areas of contrast enhancement on MR imaging in osteoporotic compression fracture may represent granulation tissue and/or fibrosis. The unenhanced areas probably represent necrosis or degeneration. The positive biopsy result can be expected in approximately 60 % of cases with metastatic tumors.

KEY WORDS: Vertebroplasty, biopsy, MR imaging

Paper 204 Starting at 3:24 PM, Ending at 3:32 PM

Minimal Vertebral Body Height Increases after Vertebroplasty Treatment of Osteoporotic Vertebral Compression Fractures

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PURPOSE

Recent reports indicate vertebral body height changes after vertebroplasty, which entails stabilizing painful vertebral compression fractures (VCF) by injecting bone cement into the vertebral body. Two groups (1, 2) describe using postural reduction to increase vertebral height, primarily in VCFs characterized with intravertebral clefts. Another group (3) observed modest increases in height without spinal manipulation. The goal is to examine potential radiographic outcomes of vertebroplasty on osteoporotic VCFs from patients treated at a private practice in the United States.

MATERIALS & METHODS

In this retrospective, consecutive case series, 43 VCFs from 43 patients with primary osteoporosis were treated by vertebroplasty. This study contained 79% (34/43) women and 21% (9/43) men. Mean patient age was 74.5 years (range 59-92 years). Mean fracture age was 18.4 days (range 5-45 days, median 16 days). Preoperative MR imaging was used to identify intravertebral clefts. Spinal manipulation was not attempted before or during the procedure. Absolute vertebral body heights (anterior, midline, and posterior) were measured in millimeters from lateral radiographs preoperatively and postoperatively. Variation in radiographic magnification was accounted for using X-Caliper (Eisenlohr Technologies, Inc., Davis, CA). Extravertebral cement extravasation was monitored during the procedure and on postoperative radiographs. We will continue to analyze a consecutive cohort that includes 250 treated levels.

RESULTS

Treated levels were between T4-L5 [65% (28/43) thoracic (T4-T12), 35% (15/43) lumbar (L1-L5), and 33% (14/43) thoracolumbar (T11-L2)]. Small but statistically significant ($p < .001$) increases in absolute vertebral body height occurred in anterior (mean $\pm$ SD, preoperative = 14.7 ± 5.4 , postoperative = 15.1 ± 5.4), midline (mean $\pm$ SD, preoperative = 13.2 ± 4.4 , postoperative = 13.6 ± 4.4), and posterior (mean $\pm$ SD, preoperative = 21.3 ± 2.2 , postoperative = 21.4 ± 2.1) measurements. When comparing fractures with intravertebral clefts ($n = 9$) to fractures with no clefts ($n = 34$), there was no statistical difference between groups regarding patient age, fracture age, or preoperative and postoperative heights (anterior, midline, and posterior). Although

the sample size was small, when analyzing absolute changes in vertebral height categorically (i.e., < 1 mm, ≥ 1 mm), fractures with clefts were more likely to experience postoperative increases in height ≥ 1 mm (anterior, $p = .0004$; midline, $p = .004$). Asymptomatic extravertebral cement leakage was detected in 16% (7/43) of levels. While mean postoperative vertebral height increase was statistically significant (anterior and midline, $p < .001$; posterior, $p = .001$) for fractures that did not have cement leaks, there was no significant postoperative increase in mean vertebral height for fractures associated with cement leaks.

CONCLUSION

The vertebroplasty patients in this case series experienced minimal but statistically significant changes in vertebral body height. Mean increases were at least 4 times smaller (approximately 0.4 mm) than that reported in recent publications (2.1 to 8.4 mm). Additional research is needed to determine how identification of intravertebral clefts may affect treatment regimens for VCFs and how vertebral anatomy restoration may affect patients' lives and health.

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3. Hiwatashi A, Moritani T, Numaguchi Y, Westesson PL. **Increase in Vertebral Body Height after Vertebroplasty.** *AJNR Am J Neuroradiol* 2003;24:185-189

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of Simplex P (PMMA) made by Stryker Howmedica Osteonics for injection into vertebral body.

KEY WORDS: Vertebroplasty, vertebral body height, spine

Paper 205 Starting at 3:32 PM, Ending at 3:40 PM

MR Imaging of Successfully Treated Vertebrae after Vertebroplasty

Dansie, D. M. • Luetmer, P. H. • Kallmes, D. F. • Lane, J. I. • Thielen, K. R. • Wald, J. T.

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PURPOSE

Whether because of recurrent compression fracture or other pathology, not all patients experience complete and lasting relief of back pain following vertebroplasty. There are few published descriptions of the expected MR findings in successfully treated vertebrae after vertebroplasty.

MATERIALS & METHODS

We identified a cohort of 31 patients who returned after vertebroplasty for evaluation of back pain, and whose back pain on follow-up was not felt to originate from the treated vertebra. This cohort was isolated by a review of each patient's medical record and imaging studies by three physicians, who made a consensus clinical determination of the pain source at follow-up. Evidence for inclusion included a positive

response to the initial procedure, physical exam, and/or imaging evidence of pathology away from the treated level at follow-up, and positive response to new treatment. Three neuroradiologists reviewed the sagittal T1 and T2 FSE images of the spine MR imaging performed during these patients' follow-up visits for back pain. The prevertebroplasty MR imaging, when available, and the postvertebroplasty plain films also were reviewed. By consensus opinion, the investigators graded imaging parameters before and after treatment including loss of height, new fractures, volume of marrow edema, and volume of marrow cemented.

RESULTS

Our cohort of 31 patients had 52 vertebrae successfully treated prior to the initial follow-up MR imaging. When these treated vertebrae were analyzed, 9 of 52 (17%) demonstrated loss of height between the vertebroplasty plain film and the follow-up MR imaging. Nine of 52 treated vertebrae (17%) had new regions of marrow edema over the imaging interval. In all but one case, the vertebrae with new edema were not the same as those with interval compression. There was an overall trend toward decreased marrow edema on follow-up, with 94% of preoperative vs 73% of follow-up vertebrae having marrow edema. However, many successfully treated vertebrae had significant marrow edema at follow-up, with 34% of vertebrae having at least 1/3 marrow volume edema. Several patients had additional vertebroplasty and/or additional follow-up MR imaging. When all follow-up scans were considered according to the interval between the vertebroplasty and the follow-up MR imaging, 24 of 24 vertebrae (100%) had marrow edema at 0-6 weeks, 20 of 22 (91%) had edema at 6 weeks-3 months, 11 of 13 (85%) at 3-6 months, and 12 of 23 (52%) at > 6 months. The extent of edema per treated vertebra declined over time, but at > 6 months, 26% of treated vertebrae had at least 1/3 marrow volume edema.

CONCLUSION

The spectrum of MR findings in vertebrae clinically successfully treated with vertebroplasty includes persistent edema, which can persist for 6 months or more after the procedure, and new fractures consisting of interval loss of height. We are aware of no other published reports describing these findings.

KEY WORDS: Vertebroplasty, MR imaging

Paper 206 Starting at 3:40 PM, Ending at 3:48 PM

CT Fluoroscopic-Guided Epidural Injections: Technique and Results

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PURPOSE

To describe the technique, pitfalls, and results using CT fluoroscopy during epidural steroid injections (ESI).

MATERIALS & METHODS

Over a 26-month period, 1036 sequential epidural injections using CT fluoroscopic guidance were performed. Needle placement success, complications and patient satisfaction were recorded prospectively.

RESULTS

CT fluoroscopy allowed successful epidural needle placement in 1033 cases (99.7%). There were three (0.3%) inadvertent intrathecal needle placements, but no other procedure related complications. Patient satisfaction was high among patients who previously had had a blind or fluoroscopic-guided ESI (n = 56), with 49 (87.5%) reporting less discomfort during the CT fluoroscopic-guided procedure.



CONCLUSION

The use of CT fluoroscopy to guide epidural needle placement is safe and accurate, allowing correct placement in over 99% of patients, with minimal discomfort and side effects.

KEY WORDS: Epidural, CT fluoroscopy, spine

Paper 207 Starting at 3:48 PM, Ending at 3:56 PM

Cervical Diskography Performed with a "Prong Deflector" for Improved Access to the Cervical Disk Spaces

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PURPOSE

Cervical diskography is a challenging procedure due to close proximity of vital neck anatomy (carotid, esophagus, pharynx) and overlap of disk spaces by the larynx (1). We describe a modification of a recently popularized technique using a "prong deflector" to improve access to the disk and stabilize neck structures for safer more rapid disk approach (2).

MATERIALS & METHODS

Cervical diskography was performed in 24 consecutive patients (60 levels) with fluoroscopic approach and 25-gauge needle disk space access. In the last 9 studies (26 lev-

els) a technique modification was employed using a “prong deflector” that allowed controlled displacement of the laryngeal cartilages, trachea, pharynx, and carotid artery while allowing the operator’s hand to remain out of the fluoroscopic beam. Factors that influence technique were evaluated to include: frequency thyroid cartilage overlapped disk spaces, successful displacement of thyroid cartilage, procedure time, and required sedation.

RESULTS

Considering all available levels, thyroid cartilage completely or partially covered the approach to a disk space at 50 levels in the 24 patients to include: C23-1/24, C34-10/24, C45-22/24, C56-18/24, and C67-4/24. In one patient, thyroid cartilage was not visible on the diskogram images. In the 9 patients where the “prong deflector” was employed, thyroid cartilage overlapped a disk space at 22 levels to include: C34-4/9, C45-9/9, C56-8/9, and C67-1/9. Cartilage completely covered the disk space in 14 of these 22 levels and partially covered disk access in 8/22. Use of the deflector caused visible disk access in the 14/22 completely covered levels and improved disk exposure in the remaining 8/22 partially covered levels. At the 60 total levels where cervical diskography was performed (C23-1, C34-10, C45-22, C56-18, C67-4) thyroid cartilage overlapped or obscured the access approach in 38 /60 levels to include: C34-5, C45-15, C56-14, C67-3. In the 9 patients where cervical diskography was assisted by the “prong deflector,” thyroid cartilage overlapped or obscured access to the targeted disk in 19 of 26 levels to include: C34-3/4, C45-7/7, C56-7/8, and C67-2/7. Use of the prong deflector resulted in exposure of the disk space in 13 covered levels with improved disk exposure and uncovering in 6 partially covered levels. In all 26 levels, the deflector allowed excellent control of neck structures with marked reduction in swallowing motion and more rapid entry to the disk space. Neck discomfort with swallowing after the procedure was no longer reported by the patient. Time to enter each disk space, complete the procedure, and required sedation per level examined were reduced.

CONCLUSION

“Prong deflector” for cervical diskography allows improved access to the disk space with reduced swallowing motion and greater control of neck vital structures such as the carotid artery. Procedure time and required sedation were reduced.

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KEY WORDS: Cervical diskography, technique, disk space

Paper 208 Starting at 3:56 PM, Ending at 4:04 PM

Combined Coblation Technology and Percutaneous Cement Injection in Treatment of Malignant Vertebral Lesions

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PURPOSE

To investigate the role of using coblation technology (low-energy radiofrequency wave that removes tissue from the treatment area via a molecular dissociation process that converts the tissue into gases which exit the treatment site) to create a tissue void cavity before performing vertebroplasty in treatment of vertebral malignant compression fractures.

MATERIALS & METHODS

Six vertebral bodies in 6 patients (4 males and 2 females) with mean age of 56 years and different metastatic lesions were included in the study after obtaining the appropriate consents. Cases included lesions with destruction of the posterior vertebral wall (two cases) vertebral and paraspinal extension (2 cases) and epidural tumor extension (two cases). Eleven G needles were used first to access the malignant lesions using a transpedicular approach under fluoroscopy guidance. A special coblation device (Arthrocare, Sunnyvale, CA) was introduced through the needle and tissue coblation was performed to create a cavity by tissue destruction. The needle then was repositioned and bone cement was injected under fluoroscopy.

RESULTS

Adequate amount of cement was injected in every case. Postprocedure imaging showed no evidence of extravasation of cement outside the presumed vertebral boundaries. All patients experienced marked pain relief. Coblation does not rely on heat energy to remove tissue, so thermal damage and tissue necrosis was avoided.

CONCLUSION

The concept of creating a cavity by tissue destruction before injecting bone cement into a malignant vertebral lesion may help to reduce complication rate, in particular extravasation of cement into the spinal canal. Further experience is needed to confirm this finding.

KEY WORDS: Vertebroplasty, coblation, spine

Paper 209 Starting at 4:04 PM, Ending at 4:12 PM

Evaluation of the Risk of Cerebral Fat Embolism during Vertebroplasty: An Experiment Using a Canine Model

Potter, J. M. • Morris, P. P. • Moody, D. M. • Baker, M. D. • Thore, C. R. • Stump, D. A. • Brown, W. R. • Challa, V. R.

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PURPOSE

Cerebral fat embolism is a complication of many invasive procedures involving the manipulation of bone, such as hip replacement surgery (1). Vertebroplasty is an increasingly popular treatment for vertebral body compression fractures where poly-

methylmethacrylate cement is injected percutaneously into the vertebral body. Because of the displacement of marrow by the cement, this procedure also has the theoretical risk of significant fat embolism. Clinically significant fat embolism has been reported in other procedures involving cement injection into the spine, such as cement augmentation of vertebral body pedicle screws (2). In sheep models, cardiovascular changes with vertebroplasty have been attributed to fat emboli (3). However, the significance of cerebral fat emboli associated with vertebroplasty currently is not known. This experiment investigates possible fat embolism during vertebroplasty using a canine model.

MATERIALS & METHODS

Four mongrel dogs were used in the experiment (average weight 32.4 kg). The dogs were anesthetized using thiopental induction and fentanyl/midazolam maintenance. Two dogs underwent four lumbar level vertebroplasty using standard trocar technique. In order to potentiate fat embolism, cement injection was continued until filling of the perivertebral veins was shown, ensuring maximal marrow displacement. Two control dogs were included also in the experiment. The first underwent a sham intervention where a trocar was used to inject saline into the paraspinal musculature to simulate cement injection. The second underwent bilateral surgical dissection of the common carotid arteries for direct injection of microspheres [100 μ m ($n \approx 1000$) and 50 μ m ($n \approx 1000 - 2000$) in the right and left common carotid arteries, respectively]. After treatment, all of the dogs underwent MR examination to evaluate for cerebral emboli. Afterwards, the animals were sacrificed and their brains, lungs, hearts, and vertebral columns harvested for radiologic, pathologic, and histologic examination. The hearts were examined for probe patent septal defects. To detect fat emboli, lung and myocardial sections were stained with Oil red O and osmium and brain sections were stained with alkaline phosphatase and osmium.

RESULTS

On histologic examination, the vertebroplasty-treated dogs did not show evidence of embolic fat in their brains or lungs. This is despite the presence of cement emboli within the lungs of both animals. No significant emboli were identified in the sham-treated dog. The microsphere-treated dog had the expected pathologic findings of embolism.

CONCLUSION

No significant findings of cerebral fat embolism could be identified in dogs treated with vertebroplasty, despite multiple treatment levels and maximal cement injection. This suggests the risk of cerebral fat embolism is low under normal treatment parameters.

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KEY WORDS: Vertebroplasty, spine, embolism

Paper 210 Starting at 4:12 PM, Ending at 4:20 PM

Percutaneous Bone Cement Injection for Sacral Fractures (Sacroplasty)

Georgy, B. A.^{1,2} • Watanabe, A.³ • Wong, W.²

¹Valley Radiology Consultants, Escondido, CA, ²University of California San Diego, San Diego, CA, ³Long Beach Memorial Hospital, Long Beach, CA

PURPOSE

Describe our experience, techniques, and outcome in treatment of sacral fractures and lesions by percutaneous bone cement injection.

MATERIALS & METHODS

Seven cases was performed by either CT guidance only (1 cases), flouroscopy guidance only (1 case), or both including CT flouroscopy (5 cases). In three cases two needles were placed in both sides. Three cases had undergone vertebroplasty before or with the sacroplasty on the lumber spine. One case had a benign cyst (next to the fracture) that was filled with cement during the procedure.

RESULTS

All patients but one, experienced marked pain relief. There may be a tendency of association between lumbar compression fractures and sacral fractures. Sacral pain may be associated with lesions other than stree fractures. Cases may need more than single needle injection for each side. Filling of all fracture lines is not required for pain relief.

CONCLUSION

Sacroplasty can be performed with high success rate. Technically it may be more challenging than vertebroplasty. More experience is needed to define the adequate amount and exact location of cement injection needed for pain relief.

KEY WORDS: Sacroplasty, sacrum, stress fracture

Paper 211 Starting at 4:20 PM, Ending at 4:28 PM

Percutaneous Radiofrequency Facet Rhizotomy for Chronic Neck Pain: Preliminary Experience

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University of Ottawa
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PURPOSE

Report the preliminary experience of the University of Ottawa with biplanar fluoroscopy-guided percutaneous radiofrequency facet rhizotomy in patients with chronic neck pain.

MATERIALS & METHODS

From May 2002 to January 2003, 16 patients with chronic neck pain who failed conservative treatment were investigated with diagnostic facet blocks. Their charts were reviewed retrospectively: pre and postprocedure visual analog scale (VAS) pain scores were compared and adverse events post-procedure were recorded. The diagnostic facet block was performed by injecting 0.5 cc of Marcaine 0.5% in the cen-

ter of each lateral articular mass at the expected location of the median branch. Patients who had a temporary relief of symptoms following the diagnostic block were candidates for radiofrequency facet rhizotomy.

RESULTS

Ten out of 16 patients had temporary relief of their symptoms following the diagnostic block. Eight out of those ten patients underwent radiofrequency facet rhizotomy. Six out of those eight patients had a successful relief of their pain at 1 month followup. The mean pre and postprocedure VAS scores were 7.3 and 3.3. Two patients reported no change in their pain level. One of those two patients underwent a repeat denervation with subsequent relief of her pain. There was no major complication (stroke, vertebral artery dissection, motor weakness). One patient complained of new intermittent left arm pain following the procedure, while another complained of occipital hyperesthesia.

CONCLUSION

Radiofrequency facet rhizotomy can be used safely to treat chronic cervical pain in patients who have had a positive response to a diagnostic facet block.

KEY WORDS: Rhizotomy, radiofrequency ablation, neck pain

Wednesday Afternoon

3:00 PM - 4:30 PM
Room 606 - 609

(44c) Adult Brain: Functional Imaging
(fMRI, MSI, MRS, PET)
(Scientific Papers 212 - 223)

See also Parallel Sessions

(44a) Adult Brain: Vascular Imaging in Tumor and Ischemia

(44b) Spine: Spinal Injections/Vertebroplasty

(44d) Spine: Trauma and Intervention

Moderators: Thomas A. Kim, MD
Jeffrey L. Sunshine, MD, PhD

Paper 212 Starting at 3:00 PM, Ending at 3:08 PM

Dynamic Whole Brain Spectroscopic Imaging and Functional MR Imaging of Ethanol Uptake in the Brain

Dydak, U.¹ • Roberts, T. P. L.^{2,3} • Tyszka, J. M.⁴ • Boesiger, P.¹ • Rowley, H. A.⁵

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²University of Toronto, Toronto, ON, CANADA, ³Toronto Western Research Institute, Toronto, ON, CANADA,

⁴California Institute of Technology, Pasadena, CA,

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PURPOSE

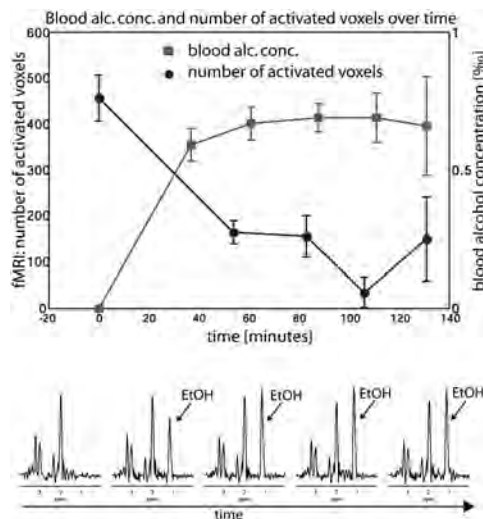
This study dynamically assessed regional changes in detectable ethanol and BOLD motor response during acute alcohol intoxication. In contrast to previous single-slice studies, we combine a fast multislice multiecho MRS imaging methodology (TSI) with BOLD fMRI to provide a more comprehensive spatiotemporal picture of acute alcohol intoxication.

MATERIALS & METHODS

A fast multislice multiecho spectroscopic imaging technique (TSI) was optimized allowing the acquisition of high-resolution data from 6 brain slices within only 11 minutes. Functional MR imaging and MRS data were acquired in three healthy subjects using a 3 T Philips Intera whole body system. Following initial baseline data acquisition, subjects drank a 1 ml/kg dose of ethanol. Blood alcohol content was monitored between data acquisitions using a breath analyzer. TSI data (6 slices, 20 x 20 voxels each, echo spacing = 144 ms, echo train length = 6) were acquired using a T/R head coil approximately every half hour up to 2.5 hours after intake. Functional MR imaging measurements were interleaved with the dynamic MRS acquisitions to assess motor coordination and performance as a function of intoxication: fMRI was acquired during a visually-guided right hand coordination task to assess changes in BOLD responses in the cerebellum and motor cortex. Spectra were analyzed using peak integration and a four-resonance model with an adaptive baseline. Functional MR imaging analysis involved motion correction and box-car correlation with task performance.

RESULTS

Subjects demonstrated a rapid rise in blood alcohol concentration over 40 minutes to a maximum of $0.74\% \pm 0.07\%$ (Figure). Dynamic TSI reveals differential accumulation of visible ethanol (methyl triplet at 1.2 ppm) in the cerebellum (Figure), cerebral cortex and CSF. The rise of detectable ethanol within CSF is particularly pronounced. Regional differences in ethanol uptake kinetics between the cerebellum and cerebrum were noted with greater levels achieved in cerebellum, but were not observed in all subjects. Functional MR imaging showed total loss of BOLD response in ipsilateral cerebellum and severe reduction in contralateral primary motor cortex at peak intoxication. The total amount of activation was reduced to $3.9\% \pm 3\%$ of the baseline activation and showed negative correlation with blood alcohol concentration ($r = -0.95$) (Figure).



CONCLUSION

Multislice, multiecho TSI has sufficient spatiotemporal resolution to map uptake kinetics of ethanol across a significant fraction of the brain and can be interleaved with other functional experiments to provide a more comprehensive, multimodal analysis of intoxication. The question of ethanol visibility in these images is important, since differences in detected ethanol between the CSF spaces and parenchyma are striking. Further experiments designed to quantify MRSI visible alcohol will be required. Functional MR imaging results are consistent with previous reports of reduced BOLD response in visual and auditory cortex during intoxication and suggest an alcohol-mediated reduction in neuronal activity in cerebellum and motor cortex during a complex motor task.

KEY WORDS: ethanol, MRS, fMRI

The authors of this work have indicated the following affiliations/disclosures: 1. GyroTools: Employment; 2. Philips Medical Systems: Consultant fees; 3. General Electric Medical Systems: Research support; 4. Toronto Image Processing Systems: Ownership.

Paper 213 Starting at 3:08 PM, Ending at 3:16 PM

Effect of Age on Visuomotor Functional MR Imaging

Tekes, A.¹ • Mohamed, M. A.¹ • Mikhelashvili-Browner, N.² • Calhoun, V. D.³ • Yousem, D. M.¹

¹Johns Hopkins Hospital, Baltimore, MD, ²Cleveland Clinics, Cleveland, OH, ³Yale University, New Haven, CT

PURPOSE

The effect of age has not been addressed adequately with visuomotor functional MR imaging (fMRI) studies. We sought to determine the effect of age on functional MR imaging experiments performed with visuomotor stimulation. We hypothesized that the functional MR imaging correlate would be a diminution in the amplitude of activation with increasing subjects' ages due to influence of restricted vascular reserve in the elderly.

MATERIALS & METHODS

We used fixed effects models to study the influence of age on fMRI patterns of the amplitude of brain activation during a block design visuomotor reaction time task in three different age groups: old (mean: 75 years, standard deviation: 6 years), middle-aged (mean: 52 years, standard deviation: 9 years) and young (mean: 29 years, standard deviation: 5 years). Each group included 7 subjects, 4 right-handed females and 3 right-handed males. Regions of interest (ROI) were defined by templates of Brodmann areas for the left primary motor area (LM1), supplementary motor area (SMA), and right and left occipital (RO, LO) visual areas. Individual subject's and group statistical parametric maps (SPMs) were generated for each ROI, and then the mean amplitude of activation was compared between age groups in each ROI using the group analysis and t test. A linear regression analysis was performed between age and activation amplitudes of each subject within each ROI.

RESULTS

In the group analysis the young age group showed higher amplitude of activation than middle and old age groups in all ROI ($P < 0.01$ uncorrected). Unpaired two tailed t test results between the groups showed significant differences between middle and young, and old and young age groups in all ROIs ($P < 0.05$), with the exception of old and young age groups in RO region ($P = 0.11$). The regression analysis of age vs amplitude of activation showed correlation r-values between 0.49 and 0.62, in all ROIs.

CONCLUSION

Given a block design visuomotor paradigm, regression analysis shows a negative correlation between age and mean amplitude of activation in all ROIs. The group analysis, and unpaired t test results reveal higher amplitude of activation in the young vs the old and middle aged groups.

KEY WORDS: Amplitude, age, visuomotor task

Paper 214 Starting at 3:16 PM, Ending at 3:24 PM

Effect of Age in Volume of Activation in Block Design and Single-Event Paradigms Using Visuomotor Functional MR Imaging

Tekes, A.¹ • Calhoun, V. D.² • Mohamed, M. A.¹ • Yagmurlu, B.³ • Mikhelashvili-Browner, N.⁴ • Yousem, D. M.¹

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PURPOSE

To determine the effect of age on visuomotor task functional MR imaging (fMRI). We hypothesized that functional MR imaging analyses would show a diminution in the volume of activation in subjects in older and younger age groups, whereas the activation would be the highest in middle age group due to vascular "efficiency" (for the young) and "reserve" (for the old) issues.

MATERIALS & METHODS

We used fixed effects models to study the influence of age on fMRI patterns of brain activation during both block and single event design visuomotor reaction time task in three dif-

ferent age groups; old (mean: 75 years, standard deviation: 6 years), middle (mean: 52 years, standard deviation: 9 years) and young (mean: 29 years, standard deviation: 5 years). Each group included 4 right-handed females and 3 right-handed males. Regions of interest (ROI) were defined as left primary motor area (LM1), supplementary motor area (SMA), right and left occipital (RO, LO) visual areas. Individual subject's and group statistical parametric maps (SPMs) were generated for each ROI at an uncorrected P value 0.01. The volumes of activation were compared between age groups in each ROI using single tailed unpaired t test.

RESULTS

We performed fixed effects groups analysis both in block and single event design for each age group. In both designs the middle age group showed more activated voxels than the old and young age groups ($P < 0.01$ uncorrected) in all regions of interest (ROI), with the exception of SMA in the single-event paradigm (Tables 1 and 2). In the block design paradigm, unpaired single tailed t test results between the groups showed statistically significant difference between middle and young age groups in SMA and LO ($P < 0.05$), and a trend towards significance in LM1 and RO ($P = 0.06$). There was no statistically significant difference between old and young, and old and middle age groups. In single event design there was a statistically significant difference between old and young age groups in all ROI, and in LO region old and middle age groups also showed a difference ($P < 0.05$).

Table 1: Activated voxels in each age group using block and single-event paradigms $p < 0.01$

	LM1	SMA	RO	LO
	block-single	block-single	block-single	block-single
OLD	1358-635	650-21	944-998	552-529
MIDDLE	1398-1922	1012-992	947-1356	609-880
YOUNG	16-1765	61-1209	18-1269	1-761

Table 2: Unpaired t test results for volume of activation between the age groups in all ROI

	pvalue	
	single event	block
LM1	upper	lower
old-middle	0.06	0.71
old-young	0.02*	0.14
middle-young	0.23	0.06*
SMA		
old-middle	0.10	0.78
old-young	0.04*	0.05
middle-young	0.31	0.02*
RO		
old-middle	0.09	0.66
old-young	0.003*	0.10
middle-young	0.20	0.06*
LO		
old-middle	0.03*	0.74
old-young	0.02*	0.22
middle-young	0.30	0.03*

LM1: Left sensorimotor area, SMA: Supplemantary motor area
LO: Left occipital visual cortex, RO: Right occipital visual cortex

* : statistically significant value

CONCLUSION

The middle aged subject group showed a greater volume of activation than the old and young groups in all regions of interest using a visuomotor task fMRI experiment with group analysis in both single event and block design paradigms.

KEY WORDS: Volume of activation, age, fMRI

Paper 215 Starting at 3:24 PM, Ending at 3:32 PM

Evaluation of a Signal Intensity Mask in the Interpretation of Functional MR Imaging Activation Maps

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University of Wisconsin Madison
Madison, WI

PURPOSE

The purpose of this study was to determine the incidence of susceptibility artifacts in functional MR imaging (fMRI) studies and their effect on fMRI readings. We hypothesized that the availability of the signal intensity maps would change the interpretation of fMRI studies in which susceptibility artifacts affected eloquent brain regions.

MATERIALS & METHODS

All fMRI studies performed with a signal intensity map (SIM) were reviewed. The SIM consisted of the initial echo-planar images (EPI) in each slice thresholded to eliminate signal from outside the brain and then overlaid on anatomical images. The cause of the artifact then was determined by examination of the images. Cases with a susceptibility artifact in eloquent brain were included in a blinded study read by four readers, first without and then with the SIM. For each reader, the number of times the interpretation changed upon viewing the SIM was counted.

RESULTS

Of 152 patients, 45% had signal loss involving the cerebral parenchyma, including 18% involving an eloquent brain region. Causes of the artifacts were: surgical site artifact, blood products, dental devices, calcium, basal ganglia calcifications, ICP monitors, glue, and air. Reading with the SIM, readers changed interpretations in 8% to 38% of patient cases, depending on reader experience and size and location of susceptibility artifact.

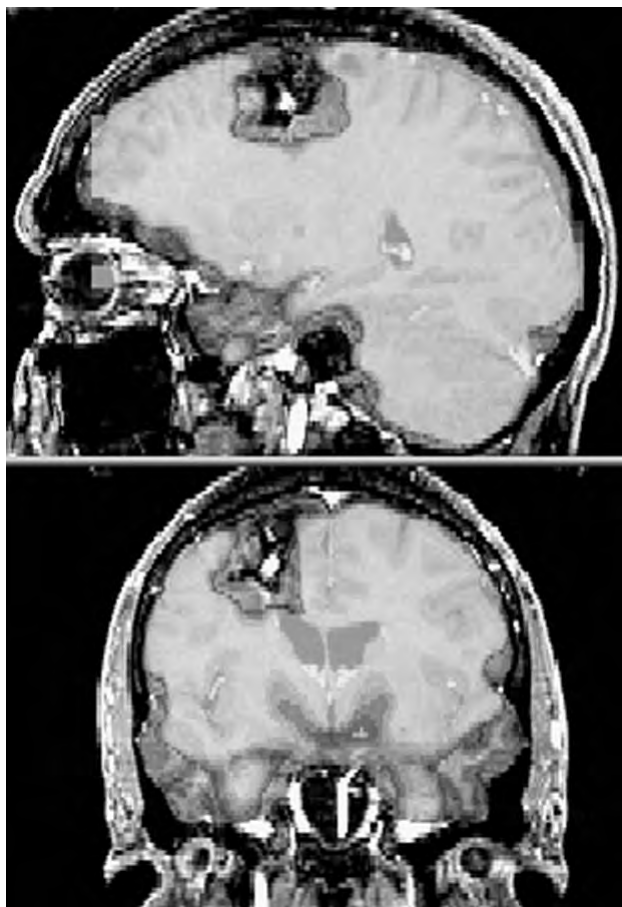


Figure. Example of the signal intensity map in a patient with an arteriovenous malformation and previous bleed. The map shows loss of signal due to susceptibility artifact in the region of the malformation.

CONCLUSION

Patients with focal cerebral lesions have a high incidence of susceptibility artifacts, whose presence and size can be determined by inspection of the SIM but not anatomical images. The availability of the SIM may affect interpretation of the fMRI.

KEY WORDS: fMRI, artifact, postprocessing

Paper 216 Starting at 3:32 PM, Ending at 3:40 PM

Functional MR Imaging Activation of Somatosensory Cortex in a Hand-Grafted Patient with Early Clinical Sensory Recovery

Neugroschl, C. S. • Denolin, V. • Schuind, F. • Van Holder, C. • Voordecker, P. • David, P. • Metens, T. • Balériaux, D.

Hospital Erasme, Universite Libre de Bruxelles
Brussels, BELGIUM

PURPOSE

To investigate the correlation between early clinical sensitive recovery in a hand-grafted patient and a cortical activity in somatosensory areas detected with functional MR imaging (fMRI).

MATERIALS & METHODS

The grafted patient is a 22-year-old man who suffered a traumatic circular-saw amputation of the right forearm. The patient had a myo-electric prosthesis during 20 months, until surgery was performed. Surgery included procurement of the upper extremity from a multiorgan 27-year-old cadaver donor. Ten days after transplantation the patient notified sensations localized at the level of the right thumb. Over weeks, his sensations progressively increased. The Tinel test was positive as early as 10 days after grafting but the somatosensory-evoked potentials analyses were negative and remained negative during 1 year. The patient had successive fMRI examinations (at 10 days and 2, 4, and 8 months) with passive tactile stimulation of the grafted hand by brushing with a rough sponge at the frequency of 3 Hz. Separate activation of his thumb and palm also were performed as the patient experienced more sensations on his thumb than on his palm. His normal left hand and a normal population including 8 healthy subjects were studied for comparison. A patient with complete brachial plexus palsy also was studied to assess the lack of fMRI signal in somatosensory areas in case of total axonal disconnection. Functional MR imaging was performed using a standard GE EPI sequence implemented on a 1.5 T unit (Philips, Intera).

RESULTS

Stimulating the grafted hand revealed significant activation in the contralateral somatosensory cortical areas in all fMRI examinations. The activation already was seen 10 days after surgery and was similar in location and intensity with the response of his normal left hand and with activation in healthy subjects. In each session, a significant difference in intensity and volume area was found between activation of the right thumb alone (where the patient had the most sensations), and palm alone; palm activation alone was always inferior to thumb activation. No activation was found in the patient with complete left brachial plexus palsy suggesting that activation with passive stimulation is dependent on sensory feedback and unlikely to be due to imagination alone. Another reason to exclude a mental activation is that a lighter tactile stimulation gave no cortical answer neither in controls nor in the grafted patient.

CONCLUSION

Functional MR imaging could detect very early activation in somatosensory areas in a hand-grafted patient that correlated well with clinical sensation recovery. These results could suggest that somatosensory cortical areas were not altered from trauma and that new peripheral inputs allowed functional cortical reactivation. Fundamental studies should be done to assess that such an early activity is due to somatosensory circuit. Still, other cases are necessary to comfort this hypothesis.

KEY WORDS: fMRI, somatosensory cortex, hand transplantation

Paper 217 Starting at 3:40 PM, Ending at 3:48 PM**Functional MR Imaging of Postsurgical Language Plasticity Following Brain Tumor Resection**

Pillai, J. J. • Allison, J. D. • Fick, J. R. • Lavin, T. B. • Balan, A.

Medical College of Georgia
Augusta, GA**PURPOSE**

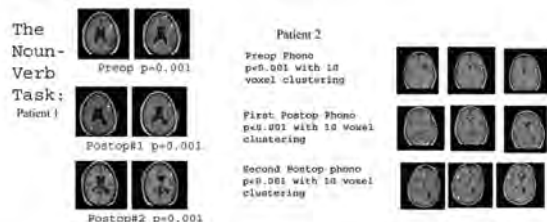
To determine the feasibility of studying brain plasticity with functional MR imaging (fMRI) following tumor resection.

MATERIALS & METHODS

Two patients underwent echo-planar fMRI on a 1.5 T system. Patient 1, a 33-year-old male, underwent left parietal anaplastic astrocytoma resection; scans were obtained 2 weeks preoperatively and 5.5 and 15.5 months postoperatively. He made a near complete recovery from initial postoperative Broca's aphasia and severe anomia over 3 months with rehabilitation. Patient 2, a 48-year-old male, underwent left frontotemporal anaplastic astrocytoma resection; scans were obtained 2 weeks preoperatively, and 5.5 and 31 months postoperatively. Immediately postoperatively, he exhibited mild speech apraxia, but regained fluent speech within 2 months. The patients performed noun-verb association and rhyming tasks. Functional datasets analyzed using SPM99 ($p < 0.001$; 10 voxel clustering) were overlaid on postcontrast T1-weighted anatomical images. Supratentorial (entire frontal and anterior temporal lobe) hemispheric rectangular volume regions of interest (ROIs) (75 mm, 75 mm, 130 mm) were used to compute activated voxel laterality indices (LI): $LI = [(left ROI) - (right ROI)] / [(left ROI) + (right ROI)]$. Group-averaged normalized functional datasets ($p < 0.001$; 10 voxel clustering) for a control group of 5 normal volunteers performing the NV task were analyzed also using identical ROIs.

RESULTS

Patient 1: For the phonological (P) task, a 44.75% decrease in LI from the first (S1) to the second scan (S2), 97.27% decrease from S2 to the third scan (S3), and 98.49% decrease from S1 to S3 were noted. For the noun-verb (NV) task, an 82.4% decrease in LI from S1 to S2 and 72.92% decrease from S1 to S3 were observed. Greater right middle frontal gyrus activation was seen in S2 and maintained in S3. Patient 2: For the NV task, a 2.65% increase from S1 to S2, 127.42% decrease from S2 to S3 and 128.12% decrease from S1 to S3 were noted. LI values (0.761 for S1, 0.782 for S2, and -0.214 for S3) demonstrated increasing right frontal activation. The P task displayed 28.96% increase in LI from S1 to S2, 562.35% decrease from S2 to S3 and 696.23% decrease from S1 to S3. LIs were 0.098 for S1, 0.126 for S2 (mildly left lateralized), and -0.583 (strongly right lateralized) for S3. More extensive and robust right inferior and middle frontal gyral activation was seen in S3 than on S1 or S2. The control group LIs during both S1 and S2 were 1.000, with no change in left lateralization noted.

**CONCLUSION**

Our study demonstrates increased right frontal BOLD activation on serial scans following left hemispheric tumor resection. These changes consistent with adaptive contralesional reorganization were noted in the early postoperative period in one patient and beyond 6 months in the other. BOLD fMRI is a useful technique to study postoperative neural plasticity.

KEY WORDS: fMRI, brain tumor, language plasticity

The authors of this work have indicated the following affiliations/disclosures: Radiological Society of North America: Work funded in part by a 2000 RSNA Seed Grant.

Paper 218 Starting at 3:48 PM, Ending at 3:56 PM**Functional MR Imaging Evaluation of Postsurgical Motor Plasticity**

Pillai, J. J. • Allison, J. D. • Fick, J. R. • King, D. W. • Smith, J. R. • Lee, M. R.

Medical College of Georgia
Augusta, GA**PURPOSE**

To determine whether BOLD functional MR imaging (fMRI) can evaluate motor cortical functional reorganization occurring as an adaptive response to surgical resection of diseased but partially functional neoplastic or epileptogenic brain tissue.

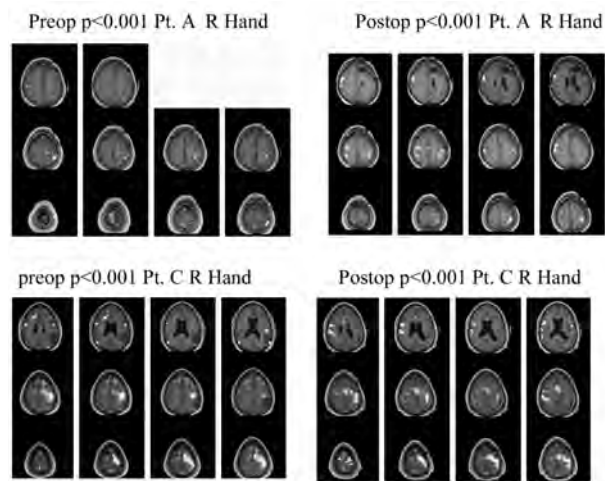
MATERIALS & METHODS

Three patients were studied with BOLD functional MR imaging at 1.5 T using identical paradigms, analysis techniques, and statistical thresholding, both preoperatively and approximately 3-6 months postoperatively. One epilepsy patient (A) underwent inferior left frontal lobe resection, while another (B) underwent right parietal partial resection and the third (C) underwent left parietal lobe tumor (anaplastic astrocytoma) resection. All patients performed bilateral hand motor (alternating finger tapping) tasks. Following overlay of SPM-99 functional datasets on MPAGE anatomical images, activated voxels ($p < 0.001$) were counted within supratentorial hemispheric regions of interest (ROIs) comprising the frontal, parietal, and temporal lobes. Regions of interest were selected in the ipsilateral (i.e., to the hand used) and contralateral cerebral hemispheres. Laterality index (LI) computations then were made based on voxel counts within each ROI, according to the following formula: $LI = [(left ROI) - (right ROI)] / [(left ROI) + (right ROI)]$. Percent changes in LI were computed. Group-averaged data was obtained for a control group of 5 normal volunteers who were scanned twice (S1 and S2) at variable interscan intervals (4 weeks to 12 months). An activation threshold of $p < 0.001$ with 5 voxel clustering was applied.

RESULTS

Increases in the number of activated contralesional hemispheric voxels were noted in all three cases, resulting in changes in laterality indices reflecting greater postoperative ipsilateral primary sensorimotor cortical activation. For patient A, a 146.89% decrease in LI was noted from the preoperative to postoperative scans during performance of the

right hand motor task. For patient B, and 81.95% increase in LI was noted during the left hand motor task, also indicating greater ipsilateral primary sensorimotor activation. For patient C, the changes in LI for both right and left hand motor tasks reflect greater ipsilateral primary sensorimotor cortical activation; the percentage changes in LI were -98.99% and +114.43%, respectively. None of the patients had undergone resection of primary sensorimotor cortex or supplementary motor cortex. The control group data revealed increased contralateral, but not ipsilateral sensorimotor cortical activation on S2 compared to S1 (70.83% increase in LI with the right hand task and 50.45% decrease in LI with the left hand task).



CONCLUSION

Compensatory spatial increases in extent of nondominant (i.e., ipsilateral and contralesional) sensorimotor cortical activation may occur following damage to the respective dominant (i.e., contralateral hemispheric) regions. Loss of the resected diseased but partially functional tissue may result in functional reorganization in the contralesional cortex, possibly with activation of previously dormant neural networks. These preliminary results suggest that fMRI may be useful for studying postsurgical plasticity in the adult brain.

KEY WORDS: Plasticity, fMRI, postsurgical

The authors of this work have indicated the following affiliations/disclosures: Radiological Society of North America: Work funded in part by a 2000 RSNA Seed Grant.

Paper 219 Starting at 3:56 PM, Ending at 4:04 PM

Diffusion Tensor Imaging of the Corpus Callosum in “Drug Naïve” Schizophrenic Patients

Gasparotti, R. • Liserre, R. • Mardighian, D. • Colleoni, M. L. • Regini, C. • Sacchetti, E.

University of Brescia
Brescia, ITALY

PURPOSE

Post-mortem and morphologic and functional MR studies support the hypothesis that schizophrenia is a disorder of cortical connectivity. Diffusion tensor imaging (DTI), a technique capable of examining water diffusion in the brain and

the organization of white matter tracts, can reveal structural disconnectivity in schizophrenia. Diffusion tensor imaging was used to analyze in vivo the neuropathology of the corpus callosum, the greatest cerebral commissural structure, in first episode schizophrenic patients with no history of exposure to neuroleptic medication (“drug naïve”).

MATERIALS & METHODS

Ten drug naïve patients (5 men, 5 women, mean age 27.7 years), fulfilling the DSM IV diagnosis of schizophrenia, and 10 healthy age-matched controls were investigated with DTI MR imaging on a 1.5 T scanner (Siemens, Germany). Diffusion tensor examinations consisted of a set of axial diffusion-weighted single shot echo-planar images ($b = 0$, $b = 500$, $b = 1000$), with diffusion gradients applied sequentially along six noncollinear directions. Subjects with a history of neurologic or systemic illness, head injury, and drug or alcohol misuse were excluded from the study. All subjects were right handed. Color maps of fractional anisotropy (FA), the most sensitive index of axonal integrity, were obtained on a voxel-by-voxel basis. Regions of interest (ROIs) were independently outlined on the FA maps by two operators in genu and splenium of the corpus callosum on the two axial sections which better displayed the structure at its full extension. Adjacent sections were checked to ensure that partial volume effects from CSF were minimized. Statistical analysis was performed with independent *t*-tests and F-tests to compare group differences in the FA values. A multivariate analysis was performed in order to investigate the relationships among FA and clinical scores.

RESULTS

Fractional anisotropy was reduced significantly in the splenium of the corpus callosum in the schizophrenic group compared with controls (*t*-test, $p = 0.03$). Fractional anisotropy in the genu did not differ significantly in the two groups. A greater dispersion of FA values was found also only in the splenium of schizophrenic subjects (F test, $p = 0.02$). There were no significant sex differences in the DTI measures for either the schizophrenic or control group. No association was found in schizophrenic patients between FA values and clinical variables such as age, duration of illness, and scores of the psychopathologic symptoms scales.

CONCLUSION

This is the first study, to our knowledge, that has examined a group of first-episode, drug naïve schizophrenic patients with DTI. The observed reduced FA values in the splenium of the corpus callosum confirm previous findings obtained in chronic schizophrenic patients and support the hypothesis of a focal disruption of commissural connectivity in schizophrenia not related to neuroleptic medication. However, it has to be determined, using other methods of analysis like voxel-based morphometry (VBM), if similar anomalies exist in other white matter tracts. According to our preliminary results DTI can become an important tool for the in vivo analysis of white matter tracts in psychiatric patients with a possible role in monitoring the efficacy of the pharmacologic treatment in future longitudinal studies.

KEY WORDS: Diffusion tensor imaging, schizophrenia, corpus callosum

Paper 220 Starting at 4:04 PM, Ending at 4:12 PM**Dynamic Statistical Spatiotemporal Map Enhances Equivalent Current Dipole Analysis of Magnetoencephalography Language Mapping in Epilepsy Patients**

Stufflebeam, S. M. • Knacke, S. • Foxed, D. • Halgren, E.

Massachusetts General Hospital, NMR Center
Charlestown, MA**PURPOSE**

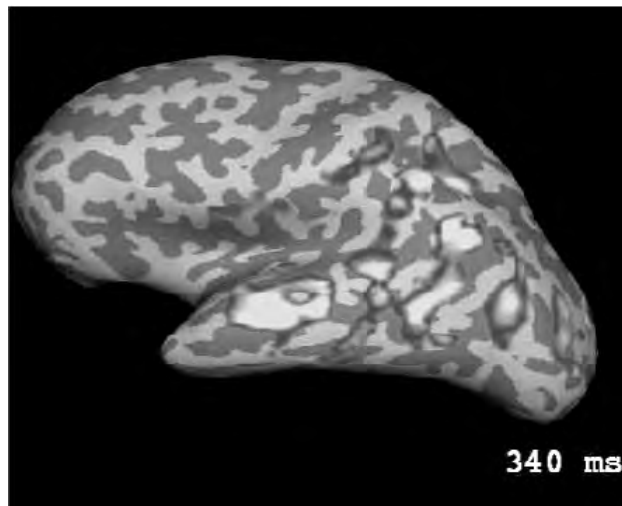
Magnetoencephalography (MEG) provides a noninvasive method for determining hemispheric language dominance (1). Healthy right-handed subjects are typically left hemisphere dominant for language in 94% of the time, but a higher degree of atypical language representation has been shown in patients with epilepsy. We prospectively investigated hemispheric index (LI) with MEG using two source analysis methods in 17 right-handed patients with medically intractable focal epilepsies: (1) single dipole (ECD); and (2) distributed method (dSPM).

MATERIALS & METHODS

A prospective analysis was performed on 17 consecutive epilepsy patients aged 14-45 years who were referred for a clinical epilepsy MEG examination. A 306-channel whole-head biomagnetometer (VectorView, Neuromag/Elekta) was used to measure the evoked magnetic fields, with simultaneous 64-electrode EEG. A visually presented reading task consisting of 240 English words was used. Equivalent current dipoles (ECD) based on a boundary element model were fitted for each hemisphere using a sequential single equivalent current dipole fit with a time range of 150 ms - 600 ms, in 1 ms steps. Only dipoles with a goodness of fit (GOF) of over 70% were considered for analysis, as proposed previously (1). The LI was calculated for each patient using the formula: $LI = (Lt - Rt) / (Lt + Rt)$, where Lt and Rt represent the number of dipoles with a GOF > 70% in each hemisphere (Rt = right; Lt = left). The noise normalized spatiotemporal map was calculated as detailed elsewhere (2), which produces a dynamic statistical parametric map (dSPM) "movie" of activated cortex. The dSPM LI was calculated by computing the area of activated cortex during the time window 150-600 ms on an inflated cortex.

RESULTS

Thirteen of 18 patients (76%) showed left hemispheric language dominance, two patients showed right LI (12%), and 2 demonstrated bilateral activation (12%), concordant with both the ECD and dSPM methods. Ten of the 13 left LI patients were diagnosed with left hemisphere epilepsy (HE). One of the patients with bilateral LI previously showed a bilateral Wada test result. The dSPM showed diffuse areas of activation not demonstrated with the ECD method (see Figure).

**CONCLUSION**

Both the traditional ECD mapping and the dSPM provide comparable LI, but dSPM provides valuable information about timing and extent of activation during language activation tasks.

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2. Dale AM, et al. **Dynamic Statistical Parametric Mapping: Combining fMRI and MEG for High-Resolution Imaging of Cortical Activity.** *Neuron* 2000;26(1):55-67

KEY WORDS: Magnetoencephalography, language, fMRI

The authors of this work have indicated the following affiliations/disclosures: MIND Institute; Funding.

Paper 221 Starting at 4:12 PM, Ending at 4:20 PM**In Vivo Single-Voxel Proton MR Spectral Patterns in the Diagnosis of Pyogenic Brain Abscess at 1.5 T**Lai, P.¹ • Pan, H.¹ • Hsu, S.¹ • Li, K.² • Ding, S.²

¹Veterans General Hospital, Kaohsiung, TAIWAN REPUBLIC OF CHINA, ²National Sun Yat-Sen University, Kaohsiung, TAIWAN REPUBLIC OF CHINA

PURPOSE

Recent reports have shown the biochemicals present in pyogenic brain abscesses, as detected with in vivo proton MR spectroscopy (¹H-MRS), to be characteristic and different from those of brain necrotic neoplasms. Our objective was to assess whether the resonance lines from lactate, lipids, acetate, succinate, and amino acids in the in vivo spectra provide a specific and sensitive signature for brain abscesses, to explore the multiplicity (diversity; variety) of spectral patterns on different metabolites and to discuss the causes of the various spectral patterns.

MATERIALS & METHODS

Seventeen patients (pyogenic brain abscesses) who underwent in vivo 1.5 T ¹H-MRS and had findings of ring-shaped enhancement after contrast agent administration were enrolled in this study. Single voxel ¹H MRS was applied

using the method of point-resolved spectroscopy (PRESS). The parameters used were a repetition time (TR) of 1600 ms and echo time (TE) of both 270 and 135 ms respectively. Six patients had in vitro 11.7-T ¹H-MR spectra obtained from the aspirated pus.

RESULTS

The MR spectra of all patients were of acceptable quality. There are three different in vivo ¹H MR spectral patterns: (A) presence of lactate at 1.3 ppm, leucine, isoleucine, and valine (referred to as cytosolic amino acids) at 0.9 ppm, alanine at 1.50 ppm, and acetate at 1.92 ppm, along with the presence or absence of succinate at 2.4 ppm and lipids (0.8-1.3 ppm); (B) presence of lactate at 1.3 ppm, cytosolic amino acids at 0.9 ppm, along with the presence or absence of lipids (0.8-1.3 ppm); (C) presence of lactate at 1.3 ppm, along with the presence or absence of lipid (0.8-1.3 ppm).

CONCLUSION

There are three different spectral patterns in pyogenic brain abscesses. The glycolytic and fermentation products of bacterial metabolism, including lactate, acetate, and succinate, vary depending on the different species of infecting microorganisms. The detection of amino acid resonances at 0.9 ppm, inverted at ¹H MR spectroscopy with a TE of 135 ms, permits the definite diagnosis of the intracranial bacterial abscesses except very small size abscesses and treated abscesses.

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KEY WORDS: Brain pyogenic abscess, MR imaging, MR spectroscopy

Paper 222 Starting at 4:20 PM, Ending at 4:25 PM

Gliomatosis Cerebri: An Unusual MR Spectroscopic Appearance of Normal Choline but Elevated Myoinositol Metabolite Levels

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PURPOSE

MR spectroscopy can noninvasively provide useful information to estimate type and grade of brain tumors, as well as to differentiate them from conditions such as infarct, demyelinating diseases, and inflammatory processes. In general, increase in the choline peak has been emphasized as a marker for brain tumors. Alternatively, increase in the myoinositol peak has been considered nonspecific. We describe a patient with histologically proven gliomatosis cerebri that presented with an abnormally elevated myoinositol level but a normal choline level.

MATERIALS & METHODS

A 73-year-old man presented with onset of confusion and disorientation. Physical examination was unremarkable. The patient had no other significant past medical history. Brain MR imaging and MR spectroscopy were performed on a 1.5 T MR unit (Symphony, Siemens, Erlangen, Germany). As definitive diagnostic evidence was required prior to the institution of therapy, a stereotactic biopsy was obtained.

RESULTS

MR imaging demonstrated abnormal low signal intensity on T1-weighted images and high signal intensity on long TR images in almost the entire left hemisphere with extension to the right hemisphere through the splenium of the corpus callosum. Minimal mass effect was identified for the size of the abnormality. Furthermore, no focal areas of enhancement were observed. MR spectroscopy demonstrated marked elevation of Myoinositol/Cr ratio (1.1), normal ratio of Cho/Cr (1.1), and decreased NAA/Cr ratio (1.3). Histologic evaluation revealed cellularity of just short of twice normal with mostly uniform round nuclei while few others showed minimal pleomorphism. The increased cellularity tracked along myelinated fiber bundles. A few mitoses were seen but no calcification, vascular proliferation, or necrosis was noted. Findings were compatible with gliomatosis cerebri.

CONCLUSION

MR spectroscopy has been introduced recently as part of the armamentarium for the investigation of neoplasm. The MR spectrum of gliomatosis cerebri, however, showed normal choline and an unexpected marked elevation of myoinositol. Increase in the myoinositol peak has been associated with gliosis, hyperosmolar states, renal failure, diabetes mellitus, and Alzheimer's disease. Castillo et al. established a trend toward elevated myoinositol levels in low-grade astrocytomas (1). They assume that the myoinositol elevation was associated with glial activation and the mildly elevated choline with a low tumor density. While gliomatosis cerebri is a more aggressive neoplasm, review of the histologic findings supports this hypothesis. Unlike the classical MR spectrum of neoplasm characterized by elevation of choline, knowledge of an increased myoinositol level may provide an indication for the correct diagnosis of neoplasm as illustrat-

ed by this patient. Of particular note, occasionally only long TE spectra (specifically for choline level determination) are obtained in the diagnostic work-up of neoplasm. Myoinositol, a metabolite with a short T2, however, will not be observed on the long TE spectra. A short TE spectra must be acquired also to obtain this potentially critical information and therefore, given these findings, a short TE spectra should be considered also in the routine spectroscopic evaluation when neoplasm is a diagnostic possibility.

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KEY WORDS: Gliomatosis cerebri, MR spectroscopy, myoinositol

Paper 223 Starting at 4:25 PM, Ending at 4:30 PM

Serial FDG-PET and MR Imaging of Transient Cortical and Cerebellar Lesions Due to Status Epilepticus

Liebeskind, D. S. • Ances, B. M. • Newberg, A. B. • Moonis, G. • Melhem, E. R. • Alavi, A.

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Philadelphia, PA

PURPOSE

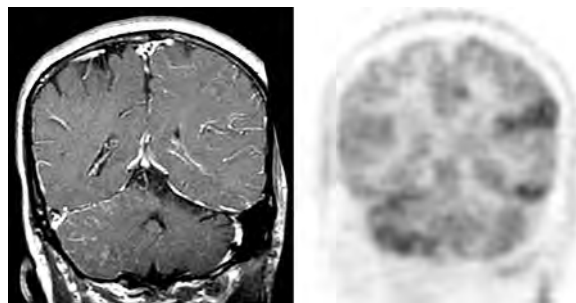
Status epilepticus may cause transient neuroimaging findings. Transient cortical abnormalities have been demonstrated on serial MR imaging, yet crossed cerebellar findings are rare. Increased demand on the inhibitory function of the cerebellum may accompany prolonged seizure activity. We describe a case of status epilepticus chronicled with serial FDG-PET and MR imaging of transient cortical and crossed cerebellar findings.

MATERIALS & METHODS

A 37-year-old man with a chronic seizure disorder presented in epilepsy partialis continua. Diagnostic evaluation included laboratory investigations, lumbar puncture, and neuroradiologic studies including CT, MR imaging, and FDG-PET.

RESULTS

MR imaging obtained 3 days after admission showed T2-hyperintensity involving the left cerebral hemisphere and right cerebellar hemisphere as well as the left thalamus without restricted diffusion. Coronal postgadolinium T1-weighted sequences revealed enhancement of the right cerebellum (Figure 1A). Subsequent PET images 5 days after admission confirmed patchy areas of intense increased FDG uptake in the left cerebral hemisphere, right cerebellum, and left thalamus corresponding to seizure activity (Figure 1B). Aggressive antiepileptic therapy culminated in resolution of seizure activity after 10 days. Repeat MR imaging and FDG-PET demonstrated interval resolution of the previous cortical and cerebellar findings.



CONCLUSION

Transient cortical and crossed cerebellar enhancement may be observed in prolonged status epilepticus. FDG-PET may confirm hypermetabolic activity consistent with seizures.

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KEY WORDS: Status epilepticus, PET, cerebellum

Wednesday Afternoon

3:00 PM - 4:30 PM

Room 611 - 612

**(44d) Spine: Trauma and Intervention
(Scientific Papers 224 - 235)**

See also Parallel Sessions

(44a) Adult Brain: Vascular Imaging in Tumor and Ischemia

(44b) Spine: Spinal Injections/Vertebroplasty

(44c) Adult Brain: Functional Imaging (fMRI, MSI, MRS, PET)

Moderators: Anil Khosla, MD
Robert M. Quencer, MD

Paper 224 Starting at 3:00 PM, Ending at 3:08 PM**Apparent Diffusion Coefficients within Spinal Cord Transplants and Surrounding White Matter Correlate with Degree of Axonal Dieback Following Injury**

Schwartz, E. D.¹ • Chin, C.¹ • Shumsky, J. S.² • Brown, K.² • Jawad, A. F.¹ • Wehrli, S.³ • Tessler, A.² • Murray, M.² • Hackney, D. B.⁴

¹University of Pennsylvania, Philadelphia, PA, ²Drexel University College of Medicine, Philadelphia, PA, ³Children's Hospital of Philadelphia, Philadelphia, PA, ⁴Beth Israel Deaconess Medical Center, Boston, MA

PURPOSE

We have shown previously that abnormal apparent diffusion coefficient values in injured spinal cord white matter and fibroblast transplants correspond with qualitative histologic findings of axon loss or regeneration. We propose that apparent diffusion coefficient (ADC) values will correlate with quantitative axon tracing in the transected rubrospinal tract (RST).

MATERIALS & METHODS

Eleven rats received right-sided lateral funiculus lesions at C3-4 (disrupting the RST) and transplantation of fibroblasts that were unmodified (Fb-UM) or modified to secrete brain-derived neurotrophic factor (Fb-BDNF). Behavioral tests measured hindlimb function for 12 weeks. The anterograde axon tracer BDA then was injected stereotactically into the red nucleus to label the injured RST axons. Diffusion imaging of fixed spinal cord specimens was obtained in 9.4 T magnet.

RESULTS

In white matter surrounding transplants, ADC values transverse to axons were elevated and ADC values longitudinal to axons were decreased. These ADC values were more abnormal closer to the transplant and this correlated with decreases in numbers of labeled RST axons. ADC values within Fb-BDNF transplants were significantly lower than Fb-UM transplants, and these lower values correlated with decreased axonal dieback. Behaviorally, all animals showed partial recovery but animals with Fb-BDNF transplants had improved hindlimb function as compared to those with Fb-UM.

CONCLUSION

Apparent diffusion coefficient values can evaluate graft function following spinal cord injury by demonstrating the degree of axon dieback and preservation. These findings will be critical in the clinical setting when histologic data is not available, and behavioral recovery may be prolonged.

KEY WORDS: Diffusion-weighted imaging, spinal cord injury, transplantation

Paper 225 Starting at 3:08 PM, Ending at 3:16 PM**Diffusion Tensor Imaging and Fiber Tracking in Spine Injury**

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¹CHU de Bicetre, Le Kremlin-Bicetre, FRANCE, ²University of North Carolina at Chapel Hill, Chapel Hill, NC

PURPOSE

To study the diffusion tensor imaging parameters variations in spinal trauma, and to visualize injured spinal fibers.

MATERIALS & METHODS

Ten patients with spinal trauma and five healthy volunteers underwent MR examination with regular sagittal SE T2-weighted and sagittal diffusion tensor imaging. Diffusion tensors were acquired using a customized parallel imaging 6-gradients directions sequence and were processed to create fractional anisotropy (FA) maps. Patients FA values in abnormal SE T2-weighted spinal areas were correlated with normal healthy volunteers FA values of same spinal location using cross-correlations and a new validation method called "No Gold Standard" method. Generated spinal FA maps were used to track the spinal fibers and to reconstruct in 3D the spinal tracts using a dedicated software.

RESULTS

In all healthy volunteers, the 3D reconstructions of spinal tract appeared continuous without broken-line aspect. In all patients, the 3D reconstructed spinal tract appeared broken in areas of spinal injury. Fractional anisotropy values in areas of abnormal SE T2-weighted signal were all decreased (0.4 +/- 0.17) when compared to FA in healthy volunteers (0.6 +/- 0.08) suggesting a local increased isotropy of the injured spine due to local edema.

CONCLUSION

Three-dimensional fiber-tracking method based on the FA of the spinal track is a useful method to visualize in "one look" abnormal areas in case of spinal injury.

KEY WORDS: Spine, diffusion tensor imaging, fiber tracking

Paper 226 Starting at 3:16 PM, Ending at 3:24 PM**Diffusion Tensor Imaging of the Human Spinal Cord at 3 T**

Summers, P.¹ • Kwiecinski, S.¹ • Staempfli, P.^{1,2} • Jaermann, T.^{1,2} • Kollias, S. S.¹

¹University Hospital Zürich, Zürich, SWITZERLAND, ²Institute for Biomedical Engineering, ETH, Zurich, SWITZERLAND

PURPOSE

MR imaging of the spinal cord is subject to strong susceptibility artifacts, respiratory and CSF motion, that severely limit efforts to study its microstructure using MR diffusion tensor imaging (DTI). Preliminary studies using spin-echo echo-planar (SE EPI), turbo-spin echo (TSE) DTI and line-scan (LS) DTI MR techniques have been used for spinal cord DTI with promising results. The combination of dedicated

receiver coils, and high performance gradients allows the minimization of image degradation and optimal signal detection of benefit to all the techniques. In this study we compare SE EPI and TSE based DTI at a 3 T MR system for high resolution imaging of the white matter tract organization in the human spinal cord.

MATERIALS & METHODS

Four volunteers have been investigated so far on a 3 T whole body MR scanner (80 mT/m, 100 mT/m/ms gradients), using a dedicated 12 element, phased-array spine coil. Diffusion tensor imaging with the acquisition of six diffusion-weighted directions and a single, reference image were obtained using SE EPI and TSE pulse sequences (TR/TE/NEX: 2 heartbeats/69-89 ms/2, FOV/SLT/AcQ Matrix/Recon Matrix: 90 mm/5 mm/90°/128°), with b-values of 400 s/mm² and 750 s/mm² in the sagittal (1 slice) and axial (8 slices) planes. Fractional anisotropy (FA) and apparent diffusion coefficient (ADC) maps were calculated. Eddy-current image warping was removed from the DTI data with a 3D registration algorithm and the diffusion tensor was derived by singular value decomposition. Multiseed-forward-integration was applied for the fiber-tracking using a custom-made software.

RESULTS

The sagittal TSE DTI images showed excellent anatomical detail with fewer distortions than the SE EPI scans. However, ghosting artifacts were more severe for TSE DTI resulting in an inhomogeneous appearance of the spinal cord on the T2-weighted reference image, which corrupted subsequent calculations of ADC and FA, but did not affect the averaged diffusion-weighted scan. In the axial orientation, the SE EPI sequence produced images of significantly higher SNR than the TSE DTI scans. The b-value = 750 s/mm² images had very low SNR and more severe distortion resulting in very noisy estimates of fractional anisotropy and eigenvector determination as compared to b = 400 s/mm² images. Fiber tracking started in seed areas placed in the lateral funiculi at the expected anatomical location of the lateral corticospinal tracts, generated 3D depictions of rostrocaudally oriented, uncrossed fiber trajectories corresponding to the known anatomical arrangement of this white matter fiber system.

CONCLUSION

Sagittal TSE DTI should be well suited to generating diffusion-weighted images in the clinical setting. Further optimization is required to reduce the effects of cord and CSF motion before tensor-related parameters can be extracted from TSE DTI data. Spin-echo echo-planar studies appear superior to TSE DTI for axial imaging of the spinal cord. Higher b-values may be required to better resolve the diffusion tensor components. Greater image resolution is also desirable to improve the anatomical accuracy of the reconstructed fiber tracts. These improvements can be achieved at the expense of increased scanning time, decreasing the appeal of the technique for routine clinical applications. Nonetheless, the multislice SE EPI with appropriate adaptation to avoid the effects of CSF and cord motion is a promising approach to achieve fiber-tracking in the spinal cord.

KEY WORDS: Spinal cord, diffusion tensor, white matter

Paper 227 Starting at 3:24 PM, Ending at 3:32 PM

Functional MR Imaging of the Human Cervical Spinal Cord

Kollias, S. S. • Kwiecinski, S. • Summers, P.

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Zürich, SWITZERLAND

PURPOSE

Noninvasive investigation of spinal cord function using functional MR imaging (fMRI) would improve greatly the neurologic assessment of patients with spinal cord pathology. Our aims were to determine whether spinal cord fMRI can be performed at an 1.5 T MR system, and investigate whether the fMRI signal is localized spatially to specific anatomical areas according to the functional organization of the spinal cord gray matter.

MATERIALS & METHODS

Activation conditions were selected to activate specific neuroanatomical areas (i.e., motor, sensory, or combined sensory-motor pathways) of the cervical spinal cord. Consisted of upper extremity motor tasks (flexion-extension) in 16 right-handed volunteers, thermal stimulation of the hand (ice bag contact) in 4, and electrical stimulation of the median nerve (3-9 mA, 8 Hz) in another 4 subjects. Imaging was performed in the transverse plane (1 mm in-plane, 7.5 mm thick) covering C5-C8 cervical cord segments. Flow-compensation and anterior saturation were used to suppress CSF flow, breathing and swallowing motion artifacts. A turbo spin-echo (5000 ms/40 ms/90°) sequence was used for the functional experiments performed in a block design (30s on/30s off). Parametric maps of significant ($P < 0.05$) activation were generated on an anatomical subregion containing the spinal cord to avoid changes in the tone or position of the surrounding muscles. Analysis was performed in the time domain on a pixel by pixel basis by computing the cross-correlation with the exercise paradigm.

RESULTS

Average fMRI signal intensity increases 3-5% time-locked to the timing of the activation conditions were observed in all experiments. The activated areas were predominantly ipsilateral to the hand involved in the exercise and located between the C5-C8 spinal cord segments. Motor tasks, elicited signal in the intermediate zone of the gray matter (interneurons in Rexed's lamina VII) with a ventrolateral extension (motor neurons in Rexed's lamina IX). Foci of activation in the dorsal horn and in the contralateral gray matter were found less consistently probably representing closely related areas, involved in the regulation of motor control. Tasks involving different myotomes were spatially localized to particular anatomical segments according to the craniocaudal segmental organization of the spinal cord and brachial plexus (hand and wrist more caudally at C7-C8, whereas elbow more cranially at C5-C6). Thermal stimulation, activated the ipsilateral dorsal horn (Rexed's laminae I to VI), corresponding to sensory input. Prominent activity was observed also in the intermediate lamina VII, which contains propriospinal neurons. Electrical repetitive stimulation of the median nerve inducing twitching of the thumb elicited activity of both dorsal and ventral areas suggesting activation of both sensory and motor fibers in the median nerve.

CONCLUSION

Our results support the findings of other investigators that intensity changes related to neuronal activation can be detected in the human cervical spinal cord using fMRI. The fact that we observe similar intensity signal changes (3-5%) with both sensory and motor stimuli and the tendency to be localized in the expected areas of neuronal involvement enhances our belief that we are observing physiologic changes related to neuronal activity in the spinal cord and not motion or artifact-related changes.

KEY WORDS: Spinal cord, fMRI, sensorimotor

Paper 228 Starting at 3:32 PM, Ending at 3:40 PM

Subarachnoid Hemorrhage Due to Isolated Spinal Artery Aneurysm Rupture in Four Patients

Massand, M. G. • Wallace, R. C.

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Phoenix, AZ

PURPOSE

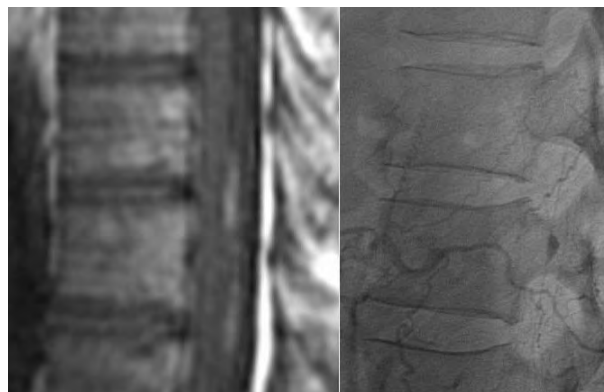
Excluding trauma as an etiology, the most common cause of subarachnoid hemorrhage is cerebral aneurysm rupture. Spinal artery aneurysms are found usually in association with arteriovenous malformations or other entities that result in increased hemodynamic stress, such as aortic coarctation or bilateral vertebral occlusion with resultant use of the spinal arterial circulation in the collateral pathway (1, 2). Isolated spinal artery aneurysms are rare (3, 4), however, since spinal arteries are in direct communication with the subarachnoid space, one etiology that should be considered in cases of spinal subarachnoid hemorrhage is ruptured spinal aneurysm.

MATERIALS & METHODS

A series of four patients presented with acute onset low back pain. Work-up included MR imaging, conventional spinal angiography, and subsequent surgery, which resulted in a diagnosis of subarachnoid hemorrhage due to spinal aneurysms in all four cases.

RESULTS

For four cases presenting to our institution with acute onset low back pain and lower extremity pain/weakness, subsequent MR imaging revealed spinal subarachnoid hemorrhage. Conventional spinal angiography was performed in all four cases. In one case (Figure), angiography revealed two aneurysms involving a posterior spinal artery branch of the left L1 segmental artery. In another case, angiography demonstrated a dissecting aneurysm of the artery of Adamkiewicz. In the third case, a small focal lesion was evident on MR imaging adjacent to the conus, but conventional angiography was negative. On operative exploration, a thrombosed aneurysm of the spinal artery was discovered. In the fourth case, angiography revealed an aneurysm involving a posterior spinal branch of the left T6 segmental artery. Operative treatment, including aneurysm excision in two of the four cases and reconstruction with muslin wrapping in the other two cases, was successful.



CONCLUSION

We conclude that spinal aneurysms may be an often overlooked cause of subarachnoid hemorrhage, and in the appropriate clinical setting, this should be considered as a possible etiology when diagnostic work-up is performed.

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KEY WORDS: Aneurysm, spinal, hemorrhage

Paper 229 Starting at 3:40 PM, Ending at 3:48 PM

MR Neurography Findings of the Bipartite Piriformis Muscle in the Evaluation of Sciatica

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PURPOSE

The piriformis syndrome often is not recognized as a cause of sciatica of nonlumbar origin (1). This muscle can irritate or compress the proximal sciatic nerve due to spasms, contraction, or entrapment. Developmental variants resulting in splitting of the sciatic nerve by a bipartite muscle has been noted in 6% of anatomical specimens (2). To our knowledge, this finding has not been well documented with MR imaging.

MATERIALS & METHODS

Over a period of 5 months, 72 adult subjects presenting with sciatica of nonlumbar origin were evaluated with MR neurography (MRN) of the pelvis at 1.5 T with a torso phased-array coil, centered ipsilateral to the symptomatic side. The MRN consisted of: standard spatial resolution (fov 26 cm) coronal STIR, axial T1 SE, and high resolution (fov 16 cm) oblique axial STIR and T1 SE perpendicular to the long axis of the sacral plexus and proximal sciatic nerve to the level of the ischial tuberosity. Multiplanar reformations, to trace the sciatic nerve along its longitudinal course, were performed.

RESULTS

Six patients (4 F, 2 M) demonstrated a bipartite variant consisting of a horizontal cleft along the inferior margin with two distinct muscle groups separated by a well defined fatty fascial plane. Splitting of the sciatic nerve, such that a common sheath is not present, with entrapment of the peroneal portion was identified. Distally, the sciatic nerve reconstituted into a common sheath in all subjects. Fascicular edema at the point of division and extending distally was noted to be: moderate (1 case), mild (2) or borderline-negative (3). In one patient, a portion of the muscle was hypointense, indicating fibrosis. In all cases, the oblique axial T1 identified this variant; whereas, this variant was overlooked easily on the direct coronal and axial sections. Another variant form was a partially split muscle, without splitting of the sciatic nerve. Careful review was important to detect any fascicular entrapment.

CONCLUSION

Recognition of the bipartite piriformis muscle is important for identifying a potential cause of entrapment sciatica as well as directing therapeutic management such as surgical release (3), since nonrecognition of this entity may lead to surgical failures (4). In one patient who underwent MR imaging-guided injection of this muscle, we have incorporated knowledge of this anatomical variant in order to direct the needle and injectate (anesthetic and steroid) towards the site of entrapment.

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KEY WORDS: Piriformis muscle, MR neurography, sciatica

Paper 230 Starting at 3:48 PM, Ending at 3:56 PM

Can Real Time Video Fluoroscopy of the Cervical Spine Differentiate the Normal from the Abnormal Spine?

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PURPOSE

In recent years video fluoroscopy of the cervical spine has been adopted by chiropractors as a way of determining subtle joint, ligament, and disk injury. They learn the technique from manuals prepared by the equipment manufacturers. They posit diagnoses that have not been proven pathologically and have created a subspecialty of video fluoroscopists. The purpose of this work is to objectively review a series of normal and purportedly abnormal video fluoroscopic examinations of the cervical spine to see if any objective abnormalities can be seen on the studies. If abnormal findings were found an attempt was made to see if there was any useful correlation with the existence of neck pain.

MATERIALS & METHODS

Ten video fluoroscopic studies that were interpreted as showing at least one diagnosable capsular injury were digitized and written to CD. Intermingled in a random fashion were 8 similar exams performed on normal volunteers with no neck pain or history of injury. Four senior spine radiologists reviewed the CDs to determine if the studies showed any abnormalities. The cases then were categorized into two groups, normal motion and abnormal motion. Special notation was made of any patient where it was felt that the study suggested the there was a greater than 50% likelihood that the patient was in pain. The data on normal and abnormal patients then were reviewed by a 5th radiologist with the code to the CD to see what diagnoses could be made.

RESULTS

Mild to moderate degenerative change was demonstrable both on the patient group and on the normal volunteer group. There was no significant difference in the cervical motion when comparing the two groups. The most common abnormality of motion was slight limitation of motion at degenerative segments. No objective diagnoses of capsular ligamentous tears could be made by any of the panel members. None of the supposedly abnormal studies were diagnosed as showing capsular injury.

CONCLUSION

The criteria used by the community of chiropractic video fluoroscopists are not considered scientifically sound. The capsular injuries that were diagnosed did not appear to be diagnosable using this method. Most of the supposed abnormalities were actually normal findings.

KEY WORDS: Real time fluoroscopy

Paper 231 Starting at 3:56 PM, Ending at 4:04 PM

Preprocedural MR Imaging for Percutaneous Vertebroplasty: Special Interest on Contrast Enhancement and Presence of Intravertebral Cleft

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PURPOSE

Percutaneous vertebroplasty (PVP) has been used for the treatment of osteoporotic fractures and metastatic tumors of the vertebral bodies (1-3). However, little has been mentioned in the literature as to MR imaging for the indication of PVP. The purpose of this study is to evaluate the role of MR imaging for the indications of PVP.

MATERIALS & METHODS

This study included 40 PVP sessions at our institution for 70 vertebral bodies in 38 consecutive patients (32 patients with osteoporotic fractures and 6 with metastatic tumors). Patients' age ranged from 46-93 years (mean 75 years). There were 14 males and 24 females. Thirty-one sessions were multilevel procedures and 19 sessions were single-level. Pre and postprocedural numerical 10-point pain scale from 0 (no pain) to 10 (the worst pain of life) was used to evaluate the clinical outcome. Preprocedural MR imaging

was available in all sessions. We retrospectively reviewed preprocedural MR findings (1.5 T) and evaluated the extent of contrast enhancement (CE) of the treated vertebral bodies on postcontrast T1-weighted imaging (T1WI) and the presence of any intravertebral cleft among treated levels on T1WI and T2-weighted imaging (T2WI). Contrast enhancement was revealed in all treated vertebral bodies except a case in which postcontrast T1WI was not obtained. Based on the extent of CE on preprocedural MR imaging, all sessions were classified into type 1 (more than 50% enhancing area of the vertebral body) and type 2 (less than 50% enhancing area of the vertebral body). In multilevel PVP sessions, the most enhancing level was evaluated. Intravertebral cleft was defined as nonenhancing linear or ellipsoid area which was isointense to cerebrospinal fluid on both T1WI and T2WI. The extent of CE and the presence of intravertebral cleft were correlated with pre and postprocedural pain score.

RESULTS

As to the extent of CE, 28 sessions were classified into type 1 and 11 sessions were type 2. Intravertebral cleft was found in 10 vertebral bodies. Pain relief was noted in 33 (82.5%) among 40 sessions when pain relief was defined as a 4-point or greater improvement in pain score. There was a trend toward better pain relief in more extensive enhancing area ($p = .057$) and the presence of intravertebral cleft ($p = .098$), although the difference was not statistically significant.



CONCLUSION

Extensive CE and intravertebral cleft on preprocedural MR imaging seem good indicators for PVP.

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KEY WORDS: Vertebroplasty, contrast enhancement, intravertebral cleft

Paper 232 Starting at 4:04 PM, Ending at 4:12 PM

Sacroplasty: An Extended Single Center Experience

Reedy, M. L. • Morris, P. • Baker, M.

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Winston-Salem, NC

PURPOSE

Sacroplasty, a variant of vertebroplasty, has been described recently as a treatment for sacral insufficiency fractures. As sacral insufficiency fractures are frequently more debilitating than the vertebral equivalent and have no alternative form of treatment, sacroplasty represents a potentially important therapeutic procedure in our aging population. The goal of this study is to identify the efficacy and safety of sacroplasty and the various technical challenges yet to be overcome.

MATERIALS & METHODS

Ten consecutive patients referred for sacroplasty were evaluated in clinic between April 2002 and November 2003. One of the 10 patients presented with spontaneous resolution of symptoms. Another is undergoing continued evaluation. Eight of the 10 patients (mean age: 68 years) presented with symptoms averaging 8.7 months in duration. Preprocedural radiologic evaluation included bone scintigraphy in 7 patients, pelvic CT in 4, and pelvic MR imaging in 6. After informed written consent for this novel procedure was obtained, the patients were treated by fluoroscopic placement of either 13 or 11 gauge needles into the sacral ala and subsequent injection of orthopedic polymethylmethacrylate cement mixed with antibiotic powder. Needle placement was targeted to minimize the risk of cement encroachment on adjacent neural foramina. Radiologic evaluation of cement distribution was performed with fluoroscopy in all patients. Additionally, postprocedural CT was obtained in 5 patients. Each patient was seen in clinic 1 month after the procedure and evaluated for changes in self-reported pain pattern, self-reported (and/or family-reported) activities of daily living (ADL), pattern of pain medication use, and pattern of support device use (walker, cane, etc.)

RESULTS

All injections were technically successful. The sacral neural foramina were patent without cement encroachment on all postprocedural fluoroscopy and cross-sectional imaging. None of the patients demonstrated clinical evidence of neurologic injury. All 8 patients exhibited significant improvement in their subjective pain profile immediately following the procedure and at 1-month follow-up. Responses ranged from 60% diminution to complete elimination of the characteristic pain. Each was able to resume many or all of the ADL previously limited by pain (returned to their full time job, resumed self-care activities). Seven of the 8 patients demonstrated significantly decreased dependence on, or total elimination of, support devices. The same proportion of patients significantly decreased or eliminated pain medication intake.



CONCLUSION

In a series of 8 of 10 consecutive patients referred for sacroplasty, all procedures were technically successful without radiologic or neurologic evidence of complication. All patients demonstrated significant improvement in their reported pain pattern and a majority (88-100%) exhibited substantial improvement in the remaining categories of evaluation. This small consecutive series suggests that sacroplasty may be performed safely with significant clinical efficacy.

KEY WORDS: Sacroplasty, vertebroplasty

Paper 233 Starting at 4:12 PM, Ending at 4:20 PM

Sacroplasty: Pain Relief for Osteoporotic Sacral Insufficiency Fractures Performed with CT Guidance

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²Lewis-Gale Medical Center, Salem, VA

PURPOSE

Describe an image-guided injection therapy for sacral insufficiency fractures related to osteoporosis. We discuss the therapeutic method, results, and its risks in five patients. This therapy quickly relieves the pain associated with these fractures in a fashion analogous to vertebroplasty.

MATERIALS & METHODS

Informed consent was obtained prior to the procedure. All five patients were positioned prone in a multislice CT scanner. Sterile procedure and moderate sedation were employed. After placing 13 gauge needles into the fracture region, polymethylmethacrylate was injected in small aliquots while cement distribution was monitored with CT imaging. This allowed even tiny leaks to be detected immediately. Clinical outcomes were measured by comparison VAS pain analysis before and after the procedure.

RESULTS

The procedure was technically successful in all patients. CT scan allowed accurate needle positioning and fine detail analysis of bone cement distribution. There were no clinical complications and all patients demonstrated a substantial improvement in their reported pain following the procedure.

CONCLUSION

The injection of polymethylmethacrylate into sacral insufficiency fractures can result in rapid pain relief. It has been safe in this small patient sample. CT guidance allowed needle positioning and cement injection monitoring that seems superior to fluoroscopy.

KEY WORDS: Sacroplasty, osteoporosis, vertebroplasty

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of Secore Bone Cement made by Parallax Medical Corp. for Sacroplasty.

The authors of this work have indicated the following affiliations/disclosures: Stryker Medical Instruments: Medical consultant.

Paper 234 Starting at 4:20 PM, Ending at 4:25 PM

CT-Guided Percutaneous Sacroplasty for a Hemorrhagic Metastatic Tumor

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St. Luke's International Hospital
Tokyo, JAPAN

PURPOSE

Percutaneous vertebroplasty has been used for the treatment of osteoporotic fractures and metastatic tumors of the vertebral bodies (1-3). Percutaneous sacroplasty for insufficiency fractures by applying the vertebroplasty technique was reported recently (4). The purpose of this presentation is to report a new clinical application of CT-guided percutaneous sacroplasty with polymethylmethacrylate (PMMA) and n-BCA (n-butyl cyanoacrylate) injection for a hemorrhagic metastasis of the sacrum.

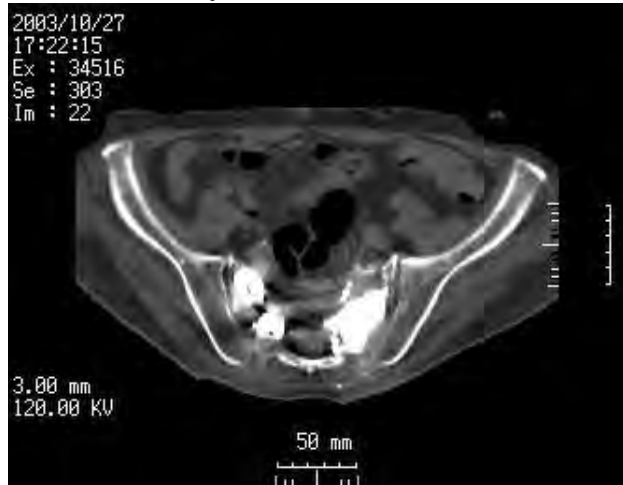
MATERIALS & METHODS

A 76-year-old male with hepatocellular carcinoma presented with unbearable left low back pain. Preoperative MR imaging revealed a large osteolytic tumor in the left sacrum, although a small osteolytic lesion was noted also in the right sacrum. Percutaneous sacroplasty was requested because of failure of narcotics, radiotherapy, transcatheter arterial embolization, and local n-BCA injection.

RESULTS

Needle placement in the sacrum was performed by using CT guidance. During the procedure a large amount of bleeding was noted through the needle and n-BCA was injected to control the bleeding. Then we injected 7 ml of the PMMA cement and barium powder mixture. Postoperative CT confirmed cement distribution within the left sacral tumor. No complication occurred. Pain relief was apparent by day 4 after the procedure and the pain had completely gone by day 10. His general activities of daily living much improved, and pain relief had been sustained. However, 3 months after the procedure he complained of severe right low back pain which was different from the previous pain. Follow-up MR imaging showed decrease in size of the left sacral metastasis, but the growth of the right sacral metastasis was noted. CT-guided sacroplasty to right sacral metastasis was requested

again. The subsequent sacroplasty using 3 ml of PMMA was performed without n-BCA injection because of little amount of bleeding. Again, the pain had diminished greatly by day 3 after the procedure, and he became ambulatory with a walker at day 48. MR imaging showed slight interval decrease in tumor size bilaterally.



CONCLUSION

Percutaneous sacroplasty with PMMA was thought to have a role to control tumor growth and relieve pain. Local n-BCA injection controlled bleeding effectively during the procedure and seems to have an additional role to control the growth of highly vascular metastatic tumors.

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KEY WORDS: Sacroplasty, CT guidance, metastasis

Paper 235 Starting at 4:25 PM, Ending at 4:30 PM

Transient Traumatic Spinal Venous Hypertension

Auler, M. • Al-Okaili, R. • Rumboldt, Z.

Medical University of South Carolina
Charleston, SC

PURPOSE

The cause of a potentially reversible myelopathy in patients with spinal dural arteriovenous fistulae is considered to be perimedullary venous congestion and hypertension. The objective of this report is to demonstrate that a reversible myelopathy may be secondary to venous hypertension as a result of a traumatic downstream obstruction.

MATERIALS & METHODS

We reviewed serial contrast-enhanced CT studies of the chest and abdomen as well as MR imaging of the thoracic spine in a trauma patient and correlated the findings with the clinical progress of the patient.

RESULTS

In this case there was a direct correlation between the onset of lower extremity paralysis, extensive edema involving thoracic spinal cord, and engorgement of the hemiazygos (arrow in Figure), and, consequently, perimedullary veins. High grade obstruction of the left brachiocephalic vein in the upper mediastinum (arrowhead in Figure) that led to the retrograde venous hypertension was caused by a traumatic hematoma. Gradual normalization of venous flow also correlated well with neurologic recovery of the patient.

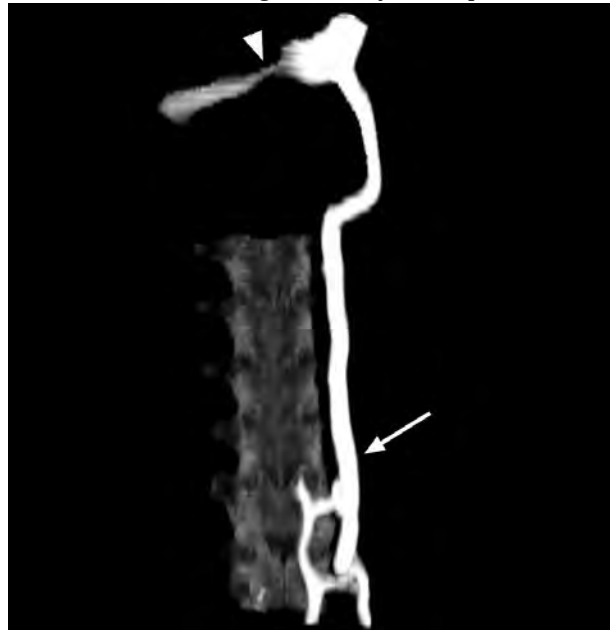


Figure is a coronal reconstruction of a CT angiogram of the chest and abdomen.

CONCLUSION

This case demonstrates how venous obstruction can lead to spinal venous hypertension, which then causes neurologic deficits. Furthermore, relief of the obstruction correlates directly with the resolution of the myelopathy. The recognition of this entity and strategies to mitigate venous hypertension should be considered in trauma patients with neurologic deficits. This case confirms the role of venous hypertension in development of myelopathy.

KEY WORDS: Venous hypertension, myelopathy, trauma

Wednesday Afternoon

3:00 PM - 4:30 PM

Room 602 - 603

(45) ELC Workshop C: Image Manipulation with Photoshop

— *Richard M. Berger, MD*

Wednesday Afternoon

4:40 PM - 5:10 PM

Room 606 - 609

(46) ELC Lecture G: Capturing and Using Image Files

— *Richard H. Wiggins, III, MD*

Wednesday Afternoon

4:40 PM - 6:10 PM

Ballroom 6 A

(47) Spinal Vascular Imaging (ASSR)

(47a) Overview of Vascular Neuroanatomy of the Spine

— *F. Reed Murtagh, MD*

(47b) Contrast-Enhanced MR Angiography of Spinal Vessels and Vascular Disease

— *Spyros Kollias, MD*

(47c) Elliptic-Centric MR Angiography of Spinal Vascular Lesions

— *Richard I. Farb, MD, FRCPC*

(47d) 3D Digital Subtraction Angiography and the Endovascular Approach to Spinal Vascular Disease

— *Ajay K. Wakhloo, MD, PhD*

(47e) Discussion

Moderators: Brian C. Bowen, MD, PhD
Gregg H Zoarski, MD

Overview of Vascular Neuroanatomy of the Spine

F. Reed Murtagh, MD

PRESENTATION SUMMARY

The blood supply of each spinal cord segment includes the anterior spinal artery and two posterior spinal arteries, all of which run the full length of the cord. The anterior spinal artery features branches that penetrate the gray matter via the anterior ventral median fissure and supply most of the anterior 2/3 of the cross-sectional area of the cord segments. Paired posterior spinal arteries bilaterally run near the dorsal root entry zones and supply the dorsal white matter and dorsal horns through various small sulci. Major features of the vasculature of the spinal cord are extensive anastomosis at all levels, forming the pial plexus. The anterior and posterior vertebral arteries are themselves formed by branches of the vertebral arteries originating near the level of the foramen magnum. Two anterior spinal arteries ventrally arise from the vertebrals and then fuse into a single anterior spinal artery as they course caudally along the anterior surface of the cord. This longitudinal vessel runs the entire length of the cord down to the conus medularis with contributions and

anastomoses along the way via branches from the thoracic and abdominal aorta called radicular arteries. One of these radicular arteries is nearly always dominant, relatively constant, arising usually on the left side at about the T12 vertebral body level, features a hairpin turn cephalad, and is designated the Artery of Adamkiewicz. It alone may supply up to as much as the caudal 2/3 of the cord. Each vertebral artery, or the posterior-inferior cerebellar artery, also gives rise dorsally to paired posterior spinal arteries which run caudad the length of the cord, frequently anastomosing, as previously described.

Contrast-Enhanced MR Angiography of Spinal Vessels and Vascular Disease

Spyros Kollias, MD

LEARNING OBJECTIVES

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

- 1) Assess the role and limitations of spinal MR angiography for guiding clinical management in patients with suspected vascular pathology of the spinal cord.
- 2) Distinguishing angioarchitectural features of spinal dural arteriovenous fistulas and spinal cord arteriovenous malformations.
- 3) Review and summarize the data acquisition technique and postprocessing algorithms of contrast-enhanced spinal MR angiography.

PRESENTATION SUMMARY

Noninvasive characterization of spinal vascular lesions is essential for guiding clinical management. The feasibility of MR Angiography (MRA) for depiction of normal spinal vessels and its role in the evaluation of patients with spinal vascular pathology will be addressed. Emphasis will be on the use of a fast three-dimensional contrast-enhanced MRA sequence for the characterization of spinal vascular lesions and for identification and accurate localization of arterial feeders and venous drainage. The technique, imaging protocol, and postprocessing algorithm of MRA data will be reviewed briefly. The added value of MRA in differentiating between spinal cord arteriovenous malformations (SCAVMs) and spinal dural arteriovenous fistulas (SDAVFs) will be emphasized. Application to the preoperative evaluation of spinal vascular tumors (hemangioblastomas and vascular teratomas) also will be covered. The accuracy and limitations of the method for detection of the millimeter-sized intradural vessels (in particular of the artery of Adamkiewicz) and for differentiating abnormal from normal vessels in comparison with that of digital subtraction angiography (DSA) will be discussed. Contrast-enhanced spinal MRA provides diagnostic information in patients with suspected spinal vascular pathology. It presently is used routinely as a screening method for suspected vascular malformations, for planning of endovascular treatment, and as a noninvasive method for follow-up evaluation after treatment. Further improvements in spatial and temporal resolution of the technique promise increased diagnostic yield.

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Elliptic-Centric MR Angiography of Spinal Vascular Lesions

Richard I. Farb, MD, FRCPC

LEARNING OBJECTIVES

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

- 1) Discuss the principles of gadolinium enhanced Elliptic-Centric MRA of the spine
- 2) Define the limitations of gad MRA today and where it will likely improve in the future

PRESENTATION SUMMARY

The ability to image spinal vascular pathology has improved substantially over the last several years owing to improved techniques of CT and MR angiography. The advent of "first pass" gadolinium-enhanced MR angiography has enhanced our ability to confirm the diagnosis and identify the feeding arteries of spinal arteriovenous malformations. Nowhere has this ability proved more useful than in the arena of spinal dural arteriovenous fistula (AVF). Our experience using the technique of autotriggered elliptic centric ordered three-dimensional gadolinium-enhanced MR angiography (ATECO MRA) for the evaluation of SDAVF as well as other spinal vascular lesions will be reviewed. The advantages as well as limitations of this technique will be emphasized. In particular, the most common causes for SDAVF localization failure at MRA will be addressed. Recent refinements of our spinal MRA technique include improved targeting of the region of interest allowing for an MRA acquisition with a smaller field of view. The potential for improvements in coil technology as well as the application of 3 T imaging to improve spinal MRA will be reviewed.

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3D Digital Subtraction Angiography and the Endovascular Approach to Spinal Vascular Disease

Ajay K. Wakhloo, MD, PhD

LEARNING OBJECTIVES

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

- 1) Assess the value and limitations of 3D angiography for spinal vascular disease
- 2) Classify spinal vascular disease
- 3) Illustrate therapeutic approach to spinal vascular disease

PRESENTATION SUMMARY

Three-dimensional (3D) angiography is highly effective in differentiating various types of spinal arteriovenous malformations (SAVMs) (e.g., intramedullary lesions from perimedullary malformations). Various 3D angiography displays are currently available: 2D cross-sections (MIP), 3D stereoscopic view, shaded surface display (SSD), fly through (virtual endoscopy), and transparent (glass) view, all of which may detect substructures of the malformation such as arterial or venous aneurysms and their relationship to the entire lesion. We can use 3D angiography to delineate the origin of AVM feeding vessels, the artery of interest from the main artery (e.g., the vertebral artery, intercostal or lumbar arteries), and vessel tortuosity to clarify anatomical ambiguity. This helps to find the appropriate angiographic views (angle) for the endovascular approach and reduce the fluoroscopy time, the amount of contrast material, the procedure length, and finally the risk of endovascular complications. If surgery is planned, 3D angiography helps to determine the relationship between the malformation and its surrounding soft tissue structures. In our experience, 3D angiography does not lead to complications, but on conscious patients, pain sensation may be experienced due to the increased amount of contrast material used. Unlike in aneurysms of the cerebrovascular system, the use of 3D angiography in spinal vascular malformations is limited by the spatial resolution and the lack of temporal information. However, 3D angiography obtained via superselective contrast injection of AVM feeding arteries may overcome some of the limitations. Potential pitfalls include incomplete filling of vascular structures, inhomogeneous contrast distribution, local flow irregularities, and motion artifacts, which may mimic vessel wall irregularities and pathology.

Discussion

Wednesday Afternoon

4:40 PM - 6:10 PM

Ballroom 6 B/C

(48) Advanced Imaging Seminar - Advanced MR and MR Spectroscopy

(48a) An Overview of High vs Low Field Imaging

— Timothy P.L. Roberts, PhD

(48b) Basics MR Spectroscopy and Clinical Applications

— Jill V. Hunter, MD

(48c) Parallel Imaging in Neuroradiology

— Christiane K. Kuhl, PhD

(48d) Advanced MR Spectroscopic Imaging Techniques

— Ulrike Dydak, PhD

Moderator: Timothy P.L. Roberts, PhD
Howard A. Rowley, MD

An Overview of High vs Low Field Imaging

Timothy P.L. Roberts, PhD

LEARNING OBJECTIVES

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

- 1) Interpret the basic SNR motivation for high field
- 2) Evaluate the increase in T1 at high field
- 3) Evaluate the shortening of T2* at high field
- 4) Interpret the increasing spectral separation at high field
- 5) Examine applications that BENEFIT from combinations of the above- e.g. arterial spin labeling, bolus tracking perfusion and 3D MRSI
- 6) Analyze the limitations of additional RF power deposition at high field
- 7) Examine the synergistic role of parallel imaging (SENSE, ASSET, iPAT) at higher field strengths

PRESENTATION SUMMARY

We are witnessing a major trend in MR imaging - namely, the clinical realization of high field (3 T) systems as additions to, or replacements for, existing 1.5 T installations. There are a number of features of higher field imaging that are worth consideration in attempting to achieve the hoped-for benefits associated with increasing field strength. Furthermore, there are several situations, where a combina-

tion of high field features offers "super-additive" advantage. On the other hand, there exist a number of potential drawbacks, that must be recognized and avoided in order not to lose the advantages high field imaging offers. Fundamentally, the appeal of higher field MR imaging is driven by basic spin physics (Boltzmann statistics) which predicts that the "signal" contribution to the collected data increases approximately as the square of the field strength, while the "noise" increases approximately linearly - in a nutshell, (potential) signal-to-noise ratio increases approximately linearly with field strength - doubling from 1.5 T to 3 T. However, a number of other issues are affected by increasing field strength - including the general lengthening (and convergence) of tissue T1s, the shortening of T2*, increased spectral separation, and increased RF power deposition. This means that protocols must be reevaluated on making the transition from 1.5 T to 3 T. Given the potential increase in SNR offered by higher field MR imaging, a few housekeeping decisions remain: what to do with the extra potential SNR? Four conceptual options are offered: Keep it - better SNR. Spend it - spatial or temporal resolution (or patient comfort). Invest it - combine with T1 lengthening, etc. to find "super-additive" benefits. Waste it - ignore T2* shortening, SAR limits, etc. These will be discussed in the context of improving image quality, reducing scan times to below physiologically critical times, increasing tag persistence in arterial spin labeling, reducing contrast agent dose in Gd-perfusion studies, reducing TE (reducing magnetic susceptibility "artifact") in Gd-perfusion studies, additional resolved resonances in magnetic resonance spectroscopy (MRS) and SAR-based limitations to fast spin-echo, true FISP (FIESTA, bFFE) and multislice extent. Finally the natural partner to higher field imaging - parallel imaging with multiple RF coils, using the principles of sensitivity encoding - will be discussed in its synergistic capacity offering possible solutions to some of the drawbacks of high field (e.g., by reducing the number of RF pulses needed, ameliorating the SAR concern), while itself benefiting from the increased SNR (compensating for one of the main limitations of parallel imaging).

Disclosure: The author of this presentation has indicated an affiliation with GE Medical Systems: Research grant.

Basics MR Spectroscopy and Clinical Applications

Jill V. Hunter, MD

LEARNING OBJECTIVES

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

- 1) Review basic acquisition techniques of 1H MRS
- 2) Recognize the six most important metabolites in the brain
- 3) Define the clinical applications and correct interpretation of 1H MRS in both children and adults

PRESENTATION SUMMARY

Proton MR spectroscopy, (1H MRS), can extract information about the chemical environment of hydrogen nuclei in a qualitative and a quantitative fashion. Data analysis in MR spectroscopy is performed by converting time-domain data to frequency domain spectra using Fourier transform. The chemical shift of a peak in a spectrum in parts per million (ppm), is independent of the strength of the magnetic field

(B0). It should be noted that shimming changes peak height and width but not the peak area. The peak area under the curve of the resulting spectra is a measurement of the number of spins. The spectrum that is seen is a frequency distribution of the nuclei in the sample and 1H MRS can be considered a histogram of the protons within different metabolites with different precession frequencies. Different acquisition and localization strategies at 1.5 T, chemical shift, and J-coupling will be discussed as well as quantification in addition to brief mention of other nuclei. The six most important metabolites demonstrable in the brain using 1H MRS, reading from right to left (Figure), are: Lactate/lipid (Lac) 1.33-1.5 ppm (low levels in normal brains); N-acetyl aspartate (NAA) 2.02 ppm; Glutamine/glutamate (Glu/Gln) 2.2-2.4 ppm; Creatine/phosphocreatine (Cr/PCr) 3.02 ppm; Choline (Cho) 3.22 ppm; Myo-inositol (mI) 3.56 ppm. 1H MRS acquired at TE = 31 ms from the basal ganglia of a child with Canavan disease (upper), and an age-matched control (lower). NAA is a marker of neuronal and axonal integrity. Choline is a marker of cell membrane turnover. Creatine acts as a marker for high-energy products. Lactate is an indicator of anaerobic metabolism and normally may be present transiently at birth. Myo-inositol is considered to be a glial marker and is an osmolyte. Clinical applications to be considered and illustrated will include diagnosis and treatment of posterior fossa and supratentorial tumors, epilepsy and seizure activity, metabolic disorders, traumatic brain injury - early and late, stroke to include hypoxic-ischemic injury, and the investigation of developmental delay. There will be discussion of the value added of 1H MRS in the clinical setting and its use in terms of predicting outcomes.

Parallel Imaging in Neuroradiology

Christiane K. Kuhl, PhD

Dr. Kuhl, Associate Professor of Radiology and Neuroradiology and Head of the MRI Division at the University of Bonn, completed her training at the University of Bonn beginning with her residency in Radiology in 1996. In 1997, she completed a residency in neurosurgery and in 1998 a fellowship in Breast Imaging. She achieved her Board certification as a neuroradiologist in 2002. Dr. Kuhl is a member of numerous professional societies and serves as a reviewer for seven international radiology journals. She is on the Editorial Board of European Radiology, RoFo, and is Associate Editor of Radiology.

LEARNING OBJECTIVES

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

- 1) Define how parallel imaging can be used in practice
- 2) Assess how parallel imaging can help reduce acquisition time
- 3) Describe how parallel imaging can help reduce susceptibility effects
- 4) Identify pitfalls or technical disadvantages of parallel imaging

PRESENTATION SUMMARY

For optimum detection and classification of disease states, virtually all clinical MR imaging applications in the field of neuroscience require both short acquisition times and a high spatial resolution. Up to now, increasing gradient strength

has been the only strategy to meet the increasing demands of advanced diagnostic imaging applications. Yet, this strategy is limited by physical, economical, and medical considerations: Increasing gradient strength is technically difficult, it is associated with significant hardware costs, and goes along with the risk to induce unwanted side effects such as peripheral neuro-stimulation. With the advent of parallel imaging techniques like SENSE, this dilemma can be overcome. In parallel imaging, phase encoding steps are replaced by exploiting the spatial information that is inherent to the spatially variable sensitivity of an array of surface coils. Several different techniques for parallel imaging have been proposed by different MR system vendors (ASSET, IPAT, SENSE); they currently allow a reduction of phase encoding steps by a reduction factor of 2 to 6 (and recently even higher). The SENSE-mediated reduction of acquisition time can be traded for improved temporal or spatial resolution of any given pulse sequence, without change of image contrast. In addition to the mere increase of image acquisition speed, the reduction of phase-encoding steps brings about two further advantages that are particularly, but not only, important for high field MR imaging: First, in single-shot EPI applications that usually are used for diffusion imaging, diffusion tensor imaging or for functional BOLD-contrast MR studies, SENSE helps to shorten the echo train length in proportion to the reduction factor. The considerably shorter echo train reduces the accumulation of phase errors during the EPI readout and, accordingly, reduces susceptibility effects like image distortions and blurring. In addition, the shorter echo train translates into a significantly higher SNR compared to sequentially phase encoding. Second, SENSE helps reduce RF deposition (regular phase encoding requires an RF pulse for every step) - this proves extremely helpful for high field imaging, where, due to the higher specific absorption rate (SAR), most pulse sequences need to be "slowed down" to avoid excessive heating of the patient. Only with parallel imaging like SENSE, the actual high-field SNR advantage can be exploited fully. Using SENSE is associated with a 30% SNR penalty - at 1.5 T, its use therefore is confined to applications or pulse sequences with high inherent SNR, like MRA studies. For high field MR imaging, the SNR loss due to SENSE is not important; in fact, higher reduction factors become clinically feasible, thus contributing to an even higher acquisition speed. For both contrast-enhanced and inflow MR angiography, SENSE helps improve spatial resolution and anatomical coverage at a given acquisition time.

Advanced MR Spectroscopic Imaging Techniques

Ulrike Dydak, PhD

Dr. Ulrike Dydak is project leader for spectroscopy at the Institute for Biomedical Engineering at the University and Swiss Federal Institute of Technology in Zurich, Switzerland. She received her diploma in physics and mathematics at the University of Vienna, Austria, in 1996. Her Ph.D. work focused on fast MR spectroscopic imaging of the brain by using parallel imaging techniques. She was involved in several clinical studies, investigating metabolic changes in neurologic disorders such as McLeod syndrome, mitochondrial encephalopathy, acute mountain sickness, or migraine. She received a postgraduate degree in Medical Physics in 2000 and her Ph.D. in MRS techniques at the Institute for

Biomedical Engineering, Swiss Federal Institute of Technology, Zurich, Switzerland in 2002. In her current research she investigates new MRS techniques that allow the dynamic study of metabolic responses to sensory stimuli or the possibility of ultra-high resolution whole brain MRSI. She has been teaching on international MR spectroscopy courses for several years, and gives practically oriented spectroscopy training for Philips Medical Systems at clinical sites. She is a member of several scientific societies (ISMRM, Organization for Human Brain Mapping, Swiss Society for Biomedical Engineering).

LEARNING OBJECTIVES

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

- 1) Identify advantages of high field strength for MRS in Higher SNR and describe Higher chemical shift differences => higher spectral separation
- 2) Utilize these advantages for multi spin-echo spectroscopic imaging to trade the higher chemical shift for higher SNR and trade the higher chemical shift for faster acquisition times
- 3) Describe parallel spectroscopic imaging and its capabilities and limitations
- 4) Distinguish the combination of parallel techniques with the advantages of higher field strength and multi spin-echo MRSI can achieve ultra-fast MRSI as well as fast whole brain MRSI

PRESENTATION SUMMARY

MR spectroscopic imaging (MRSI) can benefit from both high field strength and parallel imaging techniques. This presentation will discuss the advantages of these two aspects and how a combination of parallel imaging with high field strength may even allow for sub-minute high-resolution spectroscopic imaging or 3D MRSI in a clinically reasonable scan time. Spectroscopy gains in multiple ways from increased field strength: Besides a crucial increase in SNR, the chemical shift difference between different metabolites increases with the field strength, allowing for better separation and identification of metabolites. Importantly, this increased chemical shift difference may be used to obtain higher SNR or additional speed in advanced techniques such as multi spin-echo spectroscopic imaging (TSI) (similar to RARE, FSE, or TSE in imaging). This is because in TSI the echo spacing determines the achievable spectral resolution as well as the maximum tolerable number of echoes in the echo train. A field strength of 3 T enables twofold shorter echo spacings and thus longer echo trains while maintaining the same spectral separation between metabolites (in ppm) as at 1.5 T. By using up to six spin-echoes in the echo train, acquisition times for MRSI are reduced significantly. Examples for high resolution single slice MRSI data (32 x 32 voxels) acquired in 5 minutes, as well as for whole brain acquisitions (20 x 20 voxels x 6 slices) in 11 minutes will be discussed. Another new approach to achieve high anatomical coverage with high spatial and spectral resolution in MRSI within sensible scan times is to use the parallel imaging technique of SENSE. Two-dimensional MRSI may profit from a SENSE reduction factor in two dimensions and thus easily achieve scan time reductions of a factor of four. It will be shown how important high spatial resolution in all three spatial dimensions may be in clinical MRSI cases and how such 3D SENSE-MRSI acquisitions (24 x 24 x 8 slices) may be obtained within 14 minutes. The flexibility of parallel imaging techniques allows the combination of the two methods, enabling sub-minute scan times for single slice or 3 minute

scan times for 6 slice MRSI scans with high spatial resolution. This in return allows consideration of dynamic or functional MRSI experiments with good temporal resolution, or the imaging of dynamic metabolic processes covering the whole brain in the future.

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Disclosure: The author of this presentation has indicated the following affiliations/disclosures: 1. Gyrotools Ltd.: Ownership or partnership; 2. Philips Medical Systems: Consulting fees.

Wednesday Afternoon

5:10 PM - 5:40 PM

Room 606 - 609

(49) ELC Lecture H: Synopsis of
Scanners: Film, Flatbed, and Slides

— Gary M. Miller, MD

— Hervey D. Segall, MD

Wednesday Afternoon

5:40 PM - 6:10 PM

Room 606 - 609

(50) ELC Roundtable: Q & A with
Today's Speakers

— Richard M. Berger, MD

— Gary M. Miller, MD

— Hervey D. Segall, MD

— Richard H. Wiggins, III, MD

Notes:

Wednesday

NOTE ABOUT SCANNED IMAGES: Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2004.

Thursday Morning

8:00 AM - 9:30 AM

Ballroom 6 A

(51) Multidetector CT for Spine Imaging (ASSR)

(51a) Postprocessing and 3D Rendering for Trauma

— *Diego B. Nunez, Jr., MD, MPH*

(51b) CT Screening for Cervical Spine Trauma

— *C. Craig Blackmore, MD, MHS*

(51c) Degenerative Spine Disease Applications

— *Jeffrey A. Stone, MD*

(51d) Multislice Physics and Radiation Safety

— *James M. Kofler, Jr., PhD*

(51e) Question & Answer Session

Moderators: Jeffrey A. Stone, MD
Deepak Takhtani, MD

(MPR) and 3D image display. New ways of comprehensive real time evaluation of the spine in trauma patients is now possible. The benefits of multidetector CT acquisition parameters and the advantages of 3D volume rendering (VR) display will be discussed. The implementation of VR and the process of moving data from the scanner to the postprocessing workstation will be summarized. Specific spine injuries well suited for 2D and 3D imaging display include C1/C2 fractures, injuries resulting in translation or rotation, axially oriented fractures, articular pillar fractures, and injuries resulting from axial loading. The unusual fracture patterns found in elderly patients or in patients with preexisting conditions also are optimally assessed using MPR and VR. Interactive rotational review of volume data is performed in all positive cases of spine trauma, and MPR are obtained routinely in all cases. This approach allows for accurate and rapid patient assessment, improves surgical planning and enhances our understanding of the mechanism and effects of injury.

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CT Screening for Cervical Spine Trauma

C. Craig Blackmore, MD, MHS

C. Craig Blackmore, M.D., M.P.H., Associate Professor of Radiology at University of Washington is also Codirector, Radiology Health Services Research Section, Core Faculty Harborview Injury Prevention and Research Center. Dr. Blackmore's clinical subspecialty is Emergency and Trauma Radiology and his research interests are as follows. My research goal is to apply the tools of clinical epidemiology and outcomes research to determine the optimal imaging of emergency and trauma patients. To date, my research efforts have focused on the early radiologic care of the trauma patient, particularly of the cervical spine and of the pelvis. For each of these issues, I have followed a general approach consisting of determining the clinical probability that an injury is present in a given patient, investigating the diagnostic characteristics (sensitivity, specificity, and accuracy) of the available diagnostic tests, and then using cost-effectiveness analysis to determine the optimum imaging strategy for patients at different probabilities of injury.

Postprocessing and 3D Rendering for Trauma

Diego B. Nunez, Jr., MD, MPH

LEARNING OBJECTIVES

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

- 1) Review the principles and benefits of multidetector CT data management for implementation of routine multiplanar reformations and interactive 3D volume rendering
- 2) Discuss the clinical advantages of 3D spine imaging and specific spine injuries that are best assessed using multiplanar display

PRESENTATION SUMMARY

The role of diagnostic imaging in the evaluation of patients with suspected spine trauma has undergone significant changes and has been a topic of continuous revision over the last decade. CT currently is used as a primary screening modality and the introduction of multidetector-row configuration has allowed for high quality multiplanar reformations

LEARNING OBJECTIVES

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

- 1) Define an evidence-based imaging approach to the cervical spine in trauma patients
- 2) Assess the appropriate use of CT for trauma imaging of the cervical spine
- 3) Define interpretation pitfalls and pearls in trauma cervical spine CT

PRESENTATION SUMMARY

CT scan has supplanted traditional radiography for the initial evaluation of the cervical spine in patients with major trauma. This discussion will focus on the evidence supporting CT of the cervical spine as a primary imaging study. Included will be a discussion of accuracy of imaging, cost effectiveness analysis, and use of clinical prediction rules to identify appropriate high-risk subjects. There is abundant data on the accuracy of CT and radiography for excluding fracture in trauma patients. CT demonstrates higher sensitivity and higher specificity, particularly in poly-trauma subjects at greatest probability of fracture. However, the short-term resource costs and radiation dosage of CT are higher than radiography. Therefore determination of appropriate imaging involves use of cost-effectiveness analysis. In balance, cost-effectiveness analysis demonstrates that in appropriate high-risk subjects, CT is optimal. The advantage of CT is based on higher sensitivity resulting in improved outcome from fewer missed fractures, and higher specificity, resulting in requirement for fewer additional imaging studies, and less downstream cost. Research also suggests that primary use of CT may decrease the time required for emergency evaluation of the trauma patient. A clinical prediction rule based on mechanism of injury, presence of head injury, and presence of neurologic deficit can be used to identify appropriate high-risk subjects. There are several important questions regarding use of cervical spine CT in trauma patients for which there is still insufficient data to draw firm conclusions. The role of multidetector CT in children is not defined well. Children carry higher radiosensitivity than adults and are of substantially lower risk of fractures than adults from the same mechanism. Therefore, a pediatric subgroup of sufficiently high risk to make CT screening appropriate cannot be identified reliably. Accordingly, we do not use CT as a primary imaging modality in children. In addition, the elderly remain a diagnostically challenging group. Although the clinical predictors of cervical spine fracture are the same in the elderly as in other adult patients, the overall risk of fracture is greater and the ability to predict injury from clinical factors is decreased. Finally, although data are lacking, it is questionable as to whether fractures are detected as easily on radiography in the elderly as in younger patients. Accordingly, CT may have a greater role in elderly patients. This has not been investigated well. In summary, in selected adult trauma patients of high probability of injury, CT scan is the preferred primary imaging modality for the cervical spine.

Degenerative Spine Disease Applications

Jeffrey A. Stone, MD

LEARNING OBJECTIVES

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

- 1) Describe the basic physics and techniques of multidetector CT and its application to spine imaging
- 2) Identify the unique ways multidetector CT can aid in the evaluation of degenerative spine disease

PRESENTATION SUMMARY

Chronic neck pain, back pain, and radicular symptoms are frequent indications for spinal imaging. MR imaging is often the initial cross-sectional imaging modality used to evaluate for degenerative changes of the spine and neural element compression. Often this modality alone is sufficient for diagnosis. CT also is utilized in a subset of patients to evaluate degenerative bony change and further delineate neural element compression particularly after administration of intrathecal contrast. This presentation will address the advantages and disadvantages of multidetector CT imaging for degenerative spine disease as well as imaging parameters best used for the spinal region. The techniques and added benefits of postprocessing reconstruction and 3D rendering using multidetector CT technology will be discussed; particularly the benefits of fast scan times and better resolution in the z-axis. The application of this technology for surgical planning, particularly in regards to alignment, instability, and better evaluation of the neural foramen will be addressed.

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Multislice Physics and Radiation Safety

James M. Kofler, Jr., PhD

Dr. James Kofler received a B.S. degree from the University of Wisconsin Madison in nuclear engineering and physics in 1987, an M.S. degree in medical physics in 1989, and a Ph.D. in medical physics in 2000. He has been employed at the Mayo Clinic in Rochester, Minnesota since 1989, where his areas of responsibility have included radiographic and fluoroscopic imaging, diagnostic ultrasound, CT, and radiation dosimetry. He served as a faculty member of the Mayo School of Health-Related Sciences from 1993-2000 and became an Assistant Professor in Radiological Physics at Mayo Medical School in 1998. He also was named an Associate in the Department of Diagnostic Radiology in 1998. Dr. Kofler has several licensed technologies and one patent.

PRESENTATION SUMMARY

Multislice CT scanners present the radiologist with a large number of possible scan configuration choices, each with implications for image quality and patient dose. A basic understanding of the underlying physics principles and concepts is essential to determine optimal scan parameters while maintaining the diagnostic integrity of the image data. Radiologic risk also should be of primary consideration in prescribing CT examinations. This implies a careful balancing of task-specific image quality requirements (spatial and temporal resolution, image noise) and radiation dose, both of which are unique to the characteristics of the CT scanner (scanner features, model, and vendor). The first portion of this presentation addresses multislice CT technology concepts, with emphasis on the relationship of detector configuration to reconstructed image slice thickness. Advantages and potential issues of concern regarding multislice CT scanners also will be discussed. The second portion of this presentation discusses quantification of radiation dose in CT as well as the implications of scanner settings for image quality and dose. Several dose reduction strategies will be presented.

Question & Answer Session

Thursday Morning

8:00 AM - 9:30 AM

Ballroom 6 B/C

(52) Spinal Vascular Interventions (ASITN)

(52a) Imaging

— Kieran P. J. Murphy, MD

(52b) Pathophysiology

— Jacques E. Dion, MD

(52c) Treatment

— Christopher F. Dowd, MD

Moderators: Jacques E. Dion, MD
Philip M. Meyers, MD

Imaging

Kieran P. J. Murphy, MD

LEARNING OBJECTIVES

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

- 1) Define proper spinal vascular imaging techniques
- 2) Identify spinal angiography method

PRESENTATION SUMMARY

Spinal vascular malformations are rare and represent approximately four percent of all intraspinal masses. Eighty percent occur between the ages of 20 to 60. There are fundamentally three types: spinal dural malformations, intradural extramedullary, most common in adults, arterial venous malformations/arterial venous fistula and intramedullary AVMs. Eighty-five percent present with progressive neurologic deficits and may have a history of back pain associated with progressive sensory loss or leg weakness. Ten to twenty percent present with onset of sudden myelopathy secondary to hemorrhage causing subarachnoid hemorrhage, hematoma or epidural hematoma or spinal watershed infarct. A significant number present with foix alajouanine. This occurs secondary to decompensated venous hypertension. These patients present with a flaccid paralysis with ascending sensory symptoms. These are usually patients with preceding intramedullary cord signal abnormality who sustain some insult which further impairs their venous drainage and tips them from compensated venous hypertension to a state of profound venous stasis and venous hypertension. Spinal angiography should be meticulous and organized. It is critical to keep a rigorous track of every level studied. The inter-

costals and lumbar vessels originate in two parallel lines and are symmetrically spaced like a marching troop column. We vigorously track the gradual shift from left to right of the vessel origins from superior to inferior as they descend down the aorta. It is important to identify adjacent bony landmarks, as at the adjacent level the vessel origin will again have some relationship to the preceding bony landmarks. (We do not pass the catheter from side to side at the same level.) Our method is to study one side and then the other. If we happen to obtain imaging from the other side, we will of course take it at that time. We watch the tip of the catheter, its movement, and its sudden stability when it obtains purchase in the origin of a lumbar or intercostals vessel. Only then do we inject some contrast to identify its position. We do not constantly flush contrast into the aorta to identify our target. We move the catheter based on anatomy. It is usually possible to identify bilateral intercostals arteries from T5 to L4. Above T4 and below L4, it can be a challenge. It is important to study rigorously all bronchial vessels, the branches of the subclavian including the vertebrals and the pelvic vasculature. We do not use general anesthesia. We do not, however, allow the catheter to occlude a segmental vessel with static contrast, as this causes extreme radicular pain at that level. The vast majority of abnormal vessels seen on spinal angiography are veins. These to me resemble the appearance of a tangled telephone cord. Rigorous method and control of the data is essential. Review of the images on the consol and pixel shifting is critical to identify the cords blood supply and venous drainage. A copy of our spinal angio worksheet on which we record our runs during the procedure can be downloaded from our web site www.brainavm.net.

Disclosure: The author of this presentation has indicated an affiliation with Toshiba Medical Imaging: Research grant.

Pathophysiology

Jacques E. Dion, MD

LEARNING OBJECTIVES

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

- 1) Examine the arterial supply to the spinal cord
- 2) Examine the venous drainage of the spinal cord
- 3) List the theories for development of symptoms in spinal AVMs
- 4) Differentiate spinal cord AVMs and spinal dural AVMs

PRESENTATION SUMMARY

Proper understanding of spinal vascular pathophysiology begins with knowledge of the spinal cord's arterial vascular supply and its venous drainage. Arterial supply to the spinal cord occurs in most part from the anterior spinal axis/artery through penetrating sulcommissural arteries that supply the anterior two thirds to four fifths of the spinal cord, including the anterior horn cells, anterior and lateral corticospinal tracts, and anterior and lateral spinothalamic tracts. These penetrating branches supply the majority of the anterior gray columns and ventral portions of the dorsal gray columns of neurons. The paired posterior spinal arteries supply the posterior columns and portions of the lateral columns of the spinal cord. Venous drainage of the spinal cord occurs via two radially arranged networks. Intraspinal veins travel radially into two drainage pathways: the anterior median spinal

vein and a corresponding dorsal spinal vein which is the larger of the two; these subsequently form the coronal venous plexus, situated on the surface of the cord; these veins eventually drain through the dura via radicular veins to the epidural spinal plexus. These veins lack valves, although narrowing at the dural penetration is thought to prevent retrograde venous flow from the epidural plexus into the intradural compartment. There are several well known theories for symptom development in spinal arteriovenous malformations. The specific spinal AVM types and their hemodynamics are to be considered when applying these proposed five mechanisms: 1/ venous hypertension and thrombosis; 2/ vascular steal; 3/ subarachnoid and intraparenchymal hemorrhage; 4/ arachnoiditis; and 5/ anatomical compression. Venous hypertension has been shown to be an important factor in spinal cord ischemia in both dural AVMs and intradural AVMs. Vascular steal may cause spinal cord ischemia when high flow and low pressure within the AVM shunt blood away from the adjacent normal vasculature. Intradural AVMs can cause symptoms by this mechanism. Subarachnoid hemorrhage and intramedullary hemorrhage are responsible for the acute onset of symptoms, especially in intradural AVMs, because high flow rates and associated shear stress lead to microscopic endothelial changes of endothelial hyperplasia in the vessel wall, and the formation of arterial and nidus aneurysms and varices. Hemorrhage can arise from AVM-associated aneurysms and varices, which can occur in high flow lesions. Repeated small hemorrhages can result in arachnoiditis. Finally, anatomical compression may result from engorged veins on the spinal cord surface. Spinal cord blood flow is subject to the same autoregulatory mechanisms as those of the brain and spinal AVMs disrupt normal blood flow in many of the same ways that cerebral AVMs do. Dural AVMs are slow flow lesions in which the primary mechanism is venous hypertension. Intraparenchymal AVMs are high flow lesions and cause symptoms by hemorrhage, arterial steal, and venous hypertension.

Treatment

Christopher F. Dowd, MD

LEARNING OBJECTIVES

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

- 1) Identify and review the classification, pathophysiology, and imaging findings of vascular lesions of the spinal cord
- 2) Define the role of endovascular therapy in the treatment of vascular lesions of the spinal cord

PRESENTATION SUMMARY

Spinal vascular lesions can be divided into two broad categories: vascular shunts (malformations or fistulas) and tumors. The imaging and pathophysiology of these entities will be discussed in the preceding lectures. Endovascular approaches play an important definitive, adjunctive, or palliative therapeutic role in the treatment of these entities. The vascular shunt group can be categorized further as spinal arteriovenous malformations (SAVMs), perimedullary arteriovenous fistulas (PAVFs), dural arteriovenous fistulas (SDAVFs), and extradural (epidural or paraspinal) shunts. The endovascular treatment goals for SAVMs and PAVFs are safe microcatheterization of the feeding spinal artery, elimi-

nation or reduction of the artery-to-vein shunt (using liquid adhesive agents and occasionally particulate agents in the preoperative setting) and elimination of associated aneurysms. Dural arteriovenous fistulas usually are eliminated fully with proper liquid adhesive embolization targeting the site of the shunt along with the proximal draining vein and distal feeding artery. Extradural shunts may be targeted with a variety of embolic materials depending on the angioarchitecture of the lesion. The tumor group represents a broad category of lesions. The more vascular tumors (such as renal cell metastases or hemangioblastomas) are targeted for preoperative embolization (usually using particulate agents) to reduce intraoperative blood loss, or rarely as primary palliative procedures without surgery. One must identify and avoid inadvertent embolization of spinal arteries.

Thursday Morning

8:00 AM - 9:30 AM

Room 602 - 603

(53) ELC Workshop D: Website
Creation for the Novice

— Richard H. Wiggins, III, MD

Thursday Morning

10:15 AM - 11:45 AM

Ballroom 6 B/C

(54a) Spine: Degenerative Disk
Disease and Biomechanics
(Scientific Papers 236 - 248)

See also Parallel Sessions

(54b) Interventional: New Devices

(54c) Adult Brain: Neoplasms

(54d) Spine: General, Spinal Cord

Moderators: Alan L. Williams, MD, FACR, MBA
Johan W. M. Van Goethem, MD, PhD

Paper 236 Starting at 10:15 AM, Ending at 10:23 AM

Diffusion Imaging in Spinal Diskitis and Osteomyelitis

Sehizadeh, M. • Shimony, J. S.

Mallinckrodt Institute of Radiology
St. Louis, MO

PURPOSE

Diffusion imaging has demonstrated great clinical utility in the evaluation of the brain; however applications in the spine are in an earlier phase of development. The purpose of this study was to evaluate the use of diffusion imaging in patients with spinal infection.

MATERIALS & METHODS

Five patients with spinal diskitis/osteomyelitis were evaluated with diffusion-weighted imaging as part of a routine MR examination of the lower thoracic and lumbar spine. The group included 4 women and 1 man with an age range of 33 to 67 years. Three of the infections were at the level of L4/5 and the remaining were at T11/12 and L2/3. The examinations were performed on 1.5 T Siemens Symphony and Vision scanners (Erlangen, Germany). In 4 of the 5 patients the diagnosis was confirmed by biopsy. In the fifth the biopsy showed chronic fibrosis; however, osteomyelitis was presumed based on the clinical evaluation and the imaging findings. In addition to the routine MR examination diffusion-weighted spin-echo EPI sequence routinely used in brain imaging was adapted and performed in the sagittal plane in the spine. The sequence parameters were TR/TE 3400/94; b = 0, 500 s/mm²; field of view 25 cm; matrix 128 x 128; slice thickness 5 mm. The diffusion measurements were performed in three orthogonal planes and the apparent diffusion coefficient (ADC) was calculated using manufacturer-supplied software. Region of interest (ROI) analysis was performed in the following structures: the infected disks, in adjacent normal disk levels, adjacent areas of infected vertebral body, and in the cerebral spinal fluid. Regions of interest also were measured in healthy controls.

RESULTS

Absolute ADC values were not meaningful due to significant differences in measurements between the two types of scanners. To obtain meaningful measurements ADC values within each patient were divided by the ADC of cerebral spinal fluid. Areas consistent with abscess formation were seen in 4 of the 5 patients based on standard imaging criteria. The average fractional ADC values in all of these areas were greater than 0.60. No areas of decreased or restricted ADC were seen. The fractional anisotropy in normal disk material was less than 0.52, and this difference was larger in desiccated disks. All five patients had adjacent vertebral body edema consistent with osteomyelitis based on decrease in the T1-signal and an increase in the T2-signal. Only 3 of the 5 had measurable increased fractional ADC changes in the bone marrow with an average value of 0.47.

CONCLUSION

Areas of abscess formation in diskitis/osteomyelitis of the spine demonstrate increased diffusion values compared to normal disk space. This difference is more pronounced in comparison with desiccated disks. Although the presence of small areas of restricted diffusion cannot be excluded, this feature was not seen in the current exam. Some adjacent areas of osteomyelitis demonstrated increase in ADC values, but this was not a consistent feature. The quantitative measurements provided by diffusion could be a useful adjunct measure to standard MR imaging of the infected spine.

KEY WORDS: Diskitis, diffusion, spine

Paper 237 Starting at 10:23 AM, Ending at 10:31 AM

Diffusion Tensor Imaging of the Intervertebral Disk

Van Goethem, J. W. M. • Parizel, P. M. • Özsarlak, Ö. • Maes, M.

University Hospital Antwerp
Antwerp (Edegem), BELGIUM

PURPOSE

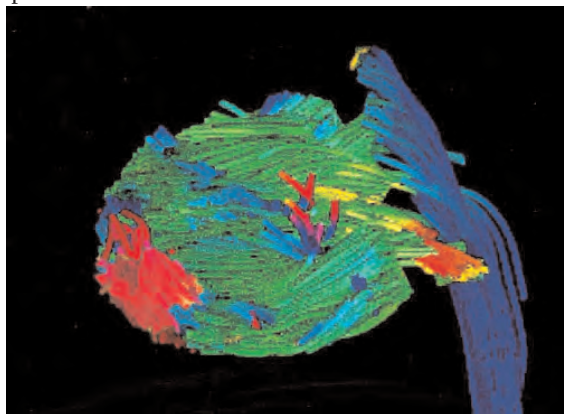
To determine the feasibility and the value of diffusion tensor MR imaging of the human intervertebral disk in vivo.

MATERIALS & METHODS

Fifteen patients with low back pain planned for MR imaging of the lumbar spine were examined. In addition to the standard lumbar examination a coronal SE EPI T2-weighted sequence of the thoracolumbar spine with diffusion sensitivity in 6 different directions was acquired. On a separate workstation diffusion tensors were calculated for each voxel in the imaged volume. Fiber tracking software was optimized to represent these diffusion tensors as more contiguous tubes representing the preferred water diffusion direction (General Hospital Corporation, USA). Color coding depended on direction of the diffusion tensors. The pattern on these color maps was correlated with the appearance of the intervertebral disk on the T2-weighted sequence, especially disk signal intensity and the presence or absence of disk hyperintensity zones (HIZ).

RESULTS

In healthy intervertebral disks with normal height and high signal intensity on T2-weighted images, diffusion in the annulus fibrosus is anisotropic. The modified fiber tracking images showed a circular pattern, especially at the outer portion of the annulus fibrosus. In degenerated intervertebral disks this finding was less consistent and in these disks a regular pattern was less often found or even absent.



CONCLUSION

Diffusion tensor imaging of the human intervertebral disk is possible in vivo, using a multidirectional diffusion-sensitive SE EPI sequence on a conventional MR scanner. In healthy disks the pattern generated out of the calculated diffusion tensors in the intervertebral disks with a modified fiber tracking software shows a layered morphology that agrees with the expected structure of the annulus fibrosus as demonstrated on light micrographs and diffusion tensor microscopy of the normal annulus fibrosus in other studies. In degenerated disks this pattern is disturbed possibly due to restricted diffusion in between the different layers and/or diffusion perpendicular trough defects in these layers disturbing the normal regular concentric anisotropic pattern.

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KEY WORDS: MR imaging, intervertebral disk, diffusion tensor

Paper 238 Starting at 10:31 AM, Ending at 10:39 AM

Evaluating Lower Back Pain: Initial Comparison of the Clinician's Impression vs Direct Anatomical Measurements on Lumbosacral MR Imaging

Choksi, V. R. • Quint, D. • Carlos, R. • Yamakawa, K. • Haig, A.

University of Michigan Health System
Ann Arbor, MI

PURPOSE

To determine if there is a correlation between clinician's impression of degree of involvement of different nerve roots and MR imaging-derived lumbosacral spinal measurements at the same level.

MATERIALS & METHODS

One hundred fourteen volunteers prospectively participated in the EMG and Back Pain study from August 2001 to April 2003. Mean age was 65.6 ± 7.5 years and 41.24% were male. The study group included asymptomatic volunteers, patients with mechanical back pain, and patients with varying degree of spinal stenosis. The clinician examined the patients and rated the degree of severity of involvement of different nerve root levels, using a 5-point ordinal scale from 1 = no disease to 5 = very severe disease. After clinician evaluation, each participant underwent noncontrast lumbosacral spine MR imaging which included T1-weighted and T2-weighted imaging in the sagittal and axial planes. A neuroradiologist blinded to the clinical evaluation measured the following MR parameters at each intervertebral disk level: a) midline anteroposterior diameter of the spinal canal (CAD), b) cross-sectional area of the spinal canal (CAA), c) midline anteroposterior diameter of the thecal sac (TSD), d) cross-sectional area of the thecal sac (TSA), e) interfacet distance between the medial osseous margins of each facet joint (IFB), and f)

interfacet distance between the medial joint capsular margins of each facet joint (IFL). Relationships between the clinician's impression of degree of involvement at each of the nerve root levels and anatomical MR measurements at the corresponding level were analyzed using Spearman's rho correlation for ordinal variables. The study was approved by the institutional review board and informed consent was obtained.

RESULTS

No significant correlation was found between the clinician's impression of degree of spinal stenosis at L1 and S1 and any of the MR measurements at the corresponding levels. At L2-3, as the CAD decreased, the clinician's impression of degree of stenosis significantly increased ($p < 0.05$). No other significant relationships were demonstrated at this level. At L4-5, as IFB and IFL decreased, the clinician's impression of degree of stenosis increased ($p < 0.05$). A similar inverse relationship was found at L5-S1 for IFB. Different statistically significant parameters and clinician's impression of degree of stenosis are summarized in Table 1.

Table 1: Correlation between clinician's impression of degree of involvement of different nerve roots

MRI imaging parameter	L2 rho (p-value)	L3	L4	L5
Canal AP diameter (CAD) L2/3	-0.189 (0.49)	-0.219 (0.02)	-	-
Canal Area (CAA) L4/5	-	-	-	-0.202 (0.031)
Interfacet distance from the bony margin (IFB) L4/5	-	-	-0.227 (0.015)	-0.234 (0.012)
Interfacet distance from the inner ligamentous margin (IFL) L4/5	-	-	-0.242 (0.01)	-0.229 (0.14)
Interfacet distance from the bony margin (IFB) L5/S1	-	-	-	-0.217 (0.02)

CONCLUSION

Although significant relationships have been described between some MR parameters and clinician's impression of degree of stenosis, there is no single parameter that is consistently predictive of the clinician's impression of degree of stenosis across all levels.

KEY WORDS: Back pain, measurements

The authors of this work have indicated the following affiliations/disclosures: National Institutes of Health: Grant #5 R01 NS41855-02; Coinvestigators, Pl.

Paper 239 Starting at 10:39 AM, Ending at 10:47 AM

High Spatial Resolution MR Imaging of Normal Cervical Nerve Roots

Moore, K. R.¹ • Dailey, A. T.² • Buswell, H.¹ • Christofferson, J.¹ • Thiede, S. G.¹

¹University of Utah, Salt Lake City, UT, ²University of Washington, Seattle, WA

PURPOSE

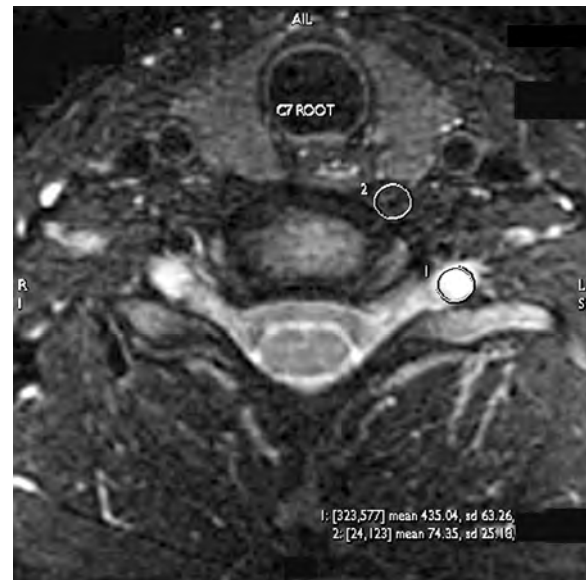
1) Validate a high spatial resolution cervical nerve root MR neurography technique using commercially available MR protocols and a phased-array surface coil. 2) Develop a normative high spatial resolution cervical nerve root imaging database.

MATERIALS & METHODS

Ten normal volunteers were imaged using high spatial resolution MR imaging pulse sequences and a phased-array surface coil at 1.5 T. High spatial resolution stacked axial T1 fast spin-echo (FSE), fat saturated T2 FSE, and (in four volunteers) axial FSEIR sequences were performed from C5 through T1. Dorsal root ganglion (DRG), proximal ventral primary ramus (VPR), and ipsilateral longus colli muscle (LCM) signal intensity was measured bilaterally at all five cervical levels, and a nerve/muscle signal intensity ratio (N/M) was calculated. The data subsequently were assessed by a statistician.

RESULTS

T1-weighted imaging technique qualitatively demonstrated the nerve roots within the osseous foramina and adjacent muscles well, but statistical analysis demonstrated significant differences between sides (left vs right), nerve root level, and DRG vs VPR. Conversely, both fat saturated T2-weighted imaging and FSEIR consistently distinguished VPR and DRG from bone and foraminal fat well, and we detected no significant difference between right and left nerve/muscle signal intensity ratios at each nerve root level. We did detect a statistically significant effect between the VPR and DRG at the same nerve root level and between either the DRG or VPR at different vertebral levels.



CONCLUSION

High spatial resolution T1-weighted imaging, fat saturated T2-weighted imaging, and FSEIR techniques produce high quality images that qualitatively demonstrate the cervical nerve root dorsal root ganglia and ventral primary rami with submillimeter in-plane resolution. Fat saturated T2-weighted imaging and FSEIR techniques are most reliable for quantitative evaluation of the DRG and VPR at the five clinically demonstrable cervical levels. These techniques may be applicable for evaluation of clinically symptomatic cervical radiculopathy patients, which should be further evaluated in future prospective studies.

KEY WORDS: MR imaging, cervical, neurography

Paper 240 Starting at 10:47 AM, Ending at 10:55 AM**Preliminary Investigation of High Spatial MR Imaging in Symptomatic Cervical Nerve Roots**Thiede, S. G.¹ • Dailey, A. T.² • Buswell, H.¹ • Moore, K. R.¹¹University of Utah, Salt Lake City, UT, ²University of Washington, Seattle, WA**PURPOSE**

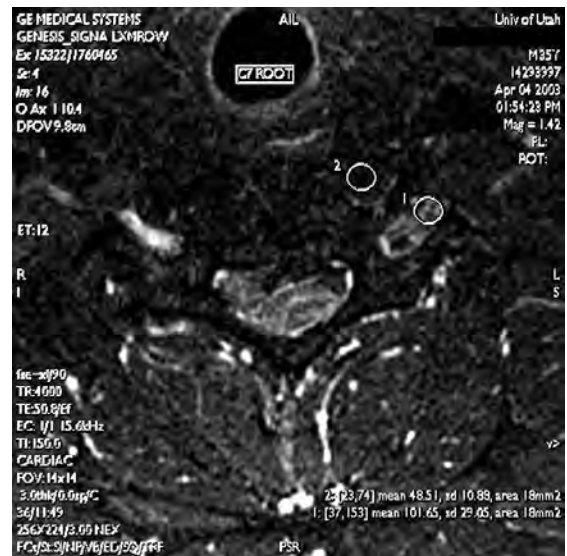
Cervical radiculopathy is debilitating and a significant cause of missed work or disability. It is frequently difficult to clinically discern which patients would benefit from surgery and which from conservative management. Conventional MR imaging is the standard imaging modality used to evaluate radiculopathy, and up to 20% of asymptomatic patients show MR imaging evidence for cervical disk disease (1). Unfortunately, conventional MR imaging may show multi-level cervical spine degenerative disk disease in patients with single level radiculopathy symptoms, while other patients may have radiculopathy symptoms without conventional MR imaging abnormality. We investigate whether high spatial resolution cervical MR neurography (MRN) using commercially available protocols and surface coil can distinguish symptomatic nerve roots from asymptomatic roots.

MATERIALS & METHODS

Ten symptomatic subjects with clinical single level cervical radiculopathy were studied prospectively under IRB approval. Stacked axial T1 fast spin-echo (FSE), fat saturated T2 FSE weighted imaging (T2WI), and axial FSEIR sequences were performed from C5 to T1, using high spatial resolution MR imaging pulse sequences and a multipurpose phased array surface coil on a 1.5 Tesla magnet. Dorsal root ganglion (DRG), proximal ventral ramus (VPR), and ipsilateral longus colli muscle (LCM) signal intensities were measured bilaterally at all five cervical levels. A nerve/muscle signal intensity ratio (N/M) and symptomatic nerve to asymptomatic nerve signal intensity ratios (NS/NA) were calculated.

RESULTS

We chose a conservative NS/NA of ≥ 1.5 as abnormal. Using this criterion, no abnormal NS/NA was identified at the symptomatic DRG side/level using either T2 or FSEIR sequences. In the VPR, 4 of 10 patients had increased NS/NA at the symptomatic side/level (T2WI and FSEIR). If an NS/NA of ≥ 1.3 or greater was selected, abnormal NS/NA were observed in one (FSEIR) and two DRGs (T2WI) and 5 (FSEIR) and 4 (T2WI) VPRs, respectively. T-test analysis of the NS/NA for patients divided into subgroups of motor, sensory, or deep tendon reflex (DTR) neurologic exam findings revealed no statistically significant difference, possibly due to the small sample size.

**CONCLUSION**

Preliminary results of high spatial resolution cervical MR imaging using T2 and FSEIR sequences shows qualitative nerve signal abnormalities in patients with single level cervical spine radiculopathy that correlates with clinical symptoms. Further evaluation with a larger numbers of prospectively enrolled subjects is merited.

REFERENCES

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KEY WORDS: Cervical spine MR neurography, cervical radiculopathy, MR imaging

Paper 241 Starting at 10:55 AM, Ending at 11:03 AM**MR Imaging of Lumbar Spinal Stenosis in Asymptomatic Volunteers: Comparison of Radiologist's Impression vs Direct Measurement of Anatomical Structures**

Choksi, V. R. • Quint, D. • Yamakawa, K. • Haig, A. J.

University of Michigan Health System
Ann Arbor, MI**PURPOSE**

To determine if there is a correlation between MR imaging-derived lumbosacral spinal measurements and radiologist's impression of degree of spinal stenosis in asymptomatic individuals.

MATERIALS & METHODS

One hundred fourteen volunteers prospectively participated in the EMG and Back Pain study from August 2001 to April 2003. Thirty-two (age 65.6 ± 7.9 years, 42.4% male) were asymptomatic based on clinical evaluation and make up the group evaluated in this study. Each participant underwent noncontrast lumbosacral spinal MR imaging including sagittal and axial T1-weighted and T2-weighted scans. A neuro-radiologist blinded to the clinical evaluation reviewed the

MR images and rendered an impression as to the degree of of spinal stenosis at each level from L1-2 through L5-S1 (0 = normal, 1 = mild, 2 = moderate, and 3 = severe). Additional anatomical MR measurements also were made at each lumbosacral intervertebral disk level: a) midline anteroposterior diameter of the spinal canal (CAD), b) cross-sectional area of the spinal canal (CAA), c) midline anteroposterior diameter of the thecal sac (TSD), d) cross-sectional area of the thecal sac (TSA), e) interfacet distance between the medial osseous margins of each facet joint (IFB), and f) interfacet distance between the medial joint capsular margins of each facet joint (IFL). Relationships between the radiologist's impression of degree of stenosis at each lumbosacral level and anatomical MR measurements at the corresponding level were analyzed using Spearman's rho correlation for ordinal variables. The study was approved by the institutional review board and informed consent was obtained.

RESULTS

In general, the radiologists' impression of the degree of stenosis significantly correlated with all anatomical measurements with the exception of IFL ($p < 0.05$). In particular, the degree of stenosis was correlated most closely with TSD (mean $r = -0.742$, $p < 0.05$) and TSA (mean $r = -0.758$, $p < 0.05$) measurements at each level except at L1/2. Specifically, as distances/areas increased, the radiologist's assessment of degree of stenosis decreased. At L1/2, the degree of stenosis most closely correlated with CAA (mean $r = -0.366$, $p < 0.05$). All results are summarized in Table 2.

Table 1: Radiologist Impression of Degree of spinal Stenosis in 33 Asymptomatic Volunteers

Degree of Stenosis	Spinal Levels				
	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1
none	29 (90.6%)	28 (84.8%)	17 (51.5%)	17 (51.5%)	27 (78.8%)
mild	3 (9.4%)	3 (9.1%)	9 (27.3%)	9 (27.3%)	6 (18.2%)
moderate	0 (0.0%)	2 (6.1%)	7 (21.2%)	4 (12.1%)	1 (3.0%)
severe	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (9.1%)	0 (0.0%)
Total	32 (100.0%)	33 (100.0%)	33 (100.0%)	33 (100.0%)	33 (100.0%)

Table 2: Correlation between the radiologist impression of severity of stenosis and MRI measurement

Anatomic landmark	Spinal Level				
	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1
Canal AP diameter (CAD)	-0.134	-0.097	-0.235	-0.629**	-0.339
Canal area (CAA)	-0.366*	-0.244	-0.373*	-0.703**	-0.538**
Thecal sac AP diameter (TSD)	-0.302	-0.541**	-0.590**	-0.742**	-0.485**
Thecal sac area (TSA)	-0.180	-0.452**	-0.618**	-0.758**	-0.523**
Interfacet distance from the bony margin (IFB)	-0.204	-0.123	-0.420*	-0.647**	0.517**
Interfacet distance from the inner ligamentous margin (IFL)	0.087	-0.305	-0.635**	0.736**	-0.391

* $p < 0.05$, ** $p < 0.01$

CONCLUSION

In asymptomatic volunteers who rarely have severe or moderate spinal stenosis, the best correlate of radiologist's impression of degree of spinal stenosis are thecal sac diameter and thecal sac area at each lumbosacral level except at the L1/2 level. Variability of correlation by level may be due to the geometry and change of curvature of the spine.

KEY WORDS: Spinal measurements

The authors of this work have indicated the following affiliations/disclosures: National Institutes of Health grant #5 R01 NS41855-02: co-investigator and PI.

Paper 242 Starting at 11:03 AM, Ending at 11:11 AM

Symptoms, Anatomy, and Outcome of Patients with Single Level Lumbar Herniated Disk

Ross, J. S.¹ • Obuchowski, N.¹ • Grooff, P.¹ • Brant-Zawadzki, M.² • Modic, M. T.¹

¹Cleveland Clinic Foundation, Cleveland, OH, ²Hoag Memorial Hospital, Newport Beach, CA

PURPOSE

The purpose of this study was to test the hypotheses that: 1) central lumbar herniations cause low back pain, and not radicular pain in the acute setting; 2) lateral herniations have an improved outcome compared with central herniations.

MATERIALS & METHODS

Two hundred forty-six patients presenting acutely with low back pain or radiculopathy were evaluated initially within 2 weeks of symptoms onset by physical exam, Roland-Morris scale (RM), and visual analogue scale (VAS). RM, VAS were repeated at weekly intervals through 6 weeks. Patients underwent MR imaging and clinical follow-up at presentation and at 6 weeks. MR studies were evaluated in a blinded fashion by three readers, using a bulge, protrusion, extrusion nomenclature. Nerve root compression (NRC) was graded on a 0-3 scale.

RESULTS

One hundred four males and 142 females completed both MR studies, with a mean age of 43 years. Ninety patients had single level herniation from the majority MR readings (38 central/52 lateral). Patients with central herniations were more likely to have protrusions ($p = 0.006$), and less likely to have radicular symptoms ($p = 0.007$), but worse higher pain scores ($p = 0.041$) than patients with lateral herniations. Radiculopathy patients had more severe NRC ($p < 0.001$), but no correlation was found between NRC and RM, or pain scores. Sixty-eight patients had outcome data at 6 weeks, with 27/40 (67.5%) lateral herniations improving and 19/28 (67.9%) central herniations improving.

CONCLUSION

Patients with acute central herniations are more likely to have low back pain, and protrusions than lateral herniations patients, but worse pain scores. There was no difference in outcome at 6 weeks between the central and lateral herniation groups. NRC did not correlate with RM score.

KEY WORDS: Lumbar, herniation, outcome

Paper 243 Starting at 11:11 AM, Ending at 11:19 AM**Assessing the Normal Cervical Spine Utilizing Real-Time Fluoroscopy: A Pilot Study**

Rothman, S. L. G. • Go, J. L. • Kim, P. E. • Zee, C. S.

University of Southern California
Los Angeles, CA**PURPOSE**

It is important occasionally to evaluate the spine's ability to move. For the most part, radiologists have been satisfied with viewing static images in flexion and extension to see if the extremes of motion are normal. It has been demonstrated that dynamic MR scanning with flexion and extension also may be useful. Fluoroscopic analysis of cervical motion was proposed as a useful modality in 1956 and has seen limited use since then. Recently, Hino, et al. have described an elegant but complex technique for evaluating cervical motion fluoroscopically and have reawakened interest in cervical dynamics. In recent years video fluoroscopy of the cervical spine has been adopted by chiropractors as a way of determining subtle joint, ligament, and disk injury. In order to evaluate cervical motion it is important to understand what is normal. It is the purpose of this presentation to demonstrate normal cervical motion on video fluoroscopy and to point out some of the anatomical variations that are seen fluoroscopically which are misinterpreted as being abnormal. One can not define the limits of normal in such a small series but the basic normal pattern can be identified.

MATERIALS & METHODS

Eight volunteers who had neither a history of trauma or were experiencing neck pain were evaluated by videofluoroscopy performed on a variety of machines. The examination was performed in various positions and evaluated motion in several planes including: 1) Lateral view - flexion - extension of the entire cervical spine; 2) oblique views of both articular processes in flexion and extension; 3) frontal view with lateral bending of the lower cervical spine; 4) open mouth views of the dens with rotation and tilting. Eight satisfactory examinations were reviewed by two senior neuroradiologists to confirm that cervical dynamics were normal.

RESULTS

Flexion and extension flow in an orderly manner from rostral to caudal. The cranio-cervical junction moves first followed in order by the descending motion segments as described by Hino, et al. As one vertebra moves forward in flexion the anterior and posterior disk margins deform. The amount of motion of one vertebra on another depends on patient flexibility and body habitus. On frontal views, the lateral borders of the disk narrow on the concave side of the tilted neck and widen on the convex side. The facet joints glide upon one another and are seen best in the oblique views. The relationship between C1 and C2 is complex. In the frontal view any rotation of C1 on C2 may cause an apparent subluxation when none is present.

CONCLUSION

In order to understand the limits of normal motion of the cervical spine one must study the normal population and understand the complex anatomical relationships that exist.

KEY WORDS: Real-time fluoroscopy, biomechanics**Paper 244 Starting at 11:19 AM, Ending at 11:24 AM****Vertebral Artery Loop Formation Resulting in Cervicobrachial Pain**

Lewandowski, R. J. • Wang, A.

William Beaumont Hospital
Royal Oak, MI**PURPOSE**

The purpose of this presentation is to illustrate the imaging findings of vertebral artery loop formation as a cause of cervicobrachial pain.

MATERIALS & METHODS

This is a review of the imaging studies of two patients diagnosed with vertebral artery loop formation as the cause of their cervical pain and radiculopathy. Radiographs, CT/angiography, and MR imaging/angiography were obtained and evaluated.

RESULTS

In each case, an aberrant course of the vertebral artery through an enlarged neural foramina was found. The effected nerve root correlated with the patients' clinical symptoms.

CONCLUSION

The differential diagnosis for patients presenting with cervicobrachial pain is broad. In patients without diskopathy, an aberrant course of the vertebral artery through the neural foramina should be suspected. Although nonspecific, radiographs may reveal enlargement of the effected neural foramina and CT scans or MR images may demonstrate soft tissue fullness at that level. The diagnosis of vertebral artery loop formation can be confirmed with either CT or MR angiography.

KEY WORDS: Vertebral artery loop formation, cervical radiculopathy, MR angiography**Paper 245 Starting at 11:24 AM, Ending at 11:29 AM****An Unusual Case of Lumbar Epidural Cryptococcomas in a Patient with Sarcoidosis**

Wottrich, S. • Bhatia, R. G. • Donovan-Post, J. • Shebert, R. T.

University of Miami
Miami, FL**PURPOSE**

Presentation of an unusual case of a patient with systemic sarcoidosis and concomitant *Cryptococcus neoformans* meningitis who developed left lower extremity radiculopathy secondary to epidural Cryptococcomas of the lumbar spine.

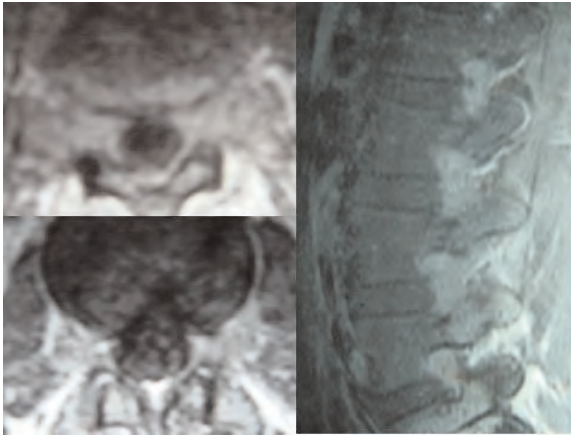
MATERIALS & METHODS

Thirty-six-year-old HIV negative Caucasian patient with depressed T-Helper cells with a CD4 cell count of 109/mm³ with progressive left lower extremity radiculopathy. A trans-bronchial biopsy (TBBX) of right lung apex and a lymph node biopsy of right femoral node were performed as well as a lumbar puncture with CSF analysis. Patient received con-

trast-enhanced MR imaging of the brain and lumbar spine. Excisional biopsy of the soft tissue lesion at L3/4 was performed.

RESULTS

Right femoral lymph node and TBBX showed noncaseating granulomas consistent with sarcoidosis. CSF Cryptococcal antigen titers (1:512) were positive for *Cryptococcus neoformans* infection. MR imaging of the brain demonstrated nonenhancing dilated Virchow-robin spaces bilaterally in the basal ganglia compatible with *Cryptococcus* inflammation. MR imaging of the lumbar spine demonstrated dural enhancement of the thecal sac as well as leptomeningeal enhancement of the nerve roots which appeared clumped. Circumferentially around the thecal sac within the epidural space and extending out the bilateral neural foramina from L1/2 to L4/5 were multilevel enhancing soft tissue lesions which were isointense on T1 and T2. There was no evidence of osteomyelitis. Excisional biopsy of the neuroforaminal lesion at L3/4 showed *Cryptococcus* infection with extensive fibrosis.



CONCLUSION

Cryptococcus neoformans is a fungus which is ubiquitous in nature that usually affects those patients with altered host defense mechanisms. *Cryptococcus* is the most common fungus to involve the central nervous system in AIDS patients; however, infection also is associated with other causes of immunosuppression as well as chronic debilitating diseases. The association of sarcoidosis and Cryptococcal infection has been described well in the literature and is most likely the result of a decrease in T-cell-mediated immunity. Specifically, patients with sarcoidosis may have decreased CD4/CD8 ratios likely due to sequestration of CD4 cells within sarcoid granulomas thus predisposing the patient to Cryptococcal infection (1). The most common complications of Cryptococcal infection in sarcoidosis patients are meningitis, osteomyelitis, and soft tissue abscesses (2). Epidural and neuroforaminal soft tissue Cryptococcomas of the spine are a rare and unusual manifestation of Cryptococcal infection, especially in the absence of concomitant vertebral osteomyelitis as in this case. It is important to recognize this association between sarcoidosis and *Cryptococcus* because the imaging features of CNS involvement of these two entities can overlap leading to the erroneous conclusion of neurosarcoidosis.

KEY WORDS: Cryptococcosis, sarcoidosis

Paper 246 Starting at 11:29 AM, Ending at 11:34 AM

Catheter-Induced Granulomas during Intrathecal Morphine Administration

Karagianis, A.¹ • Walker, M. T.¹ • Futterer, S. F.¹ • Klufas, R.²

¹Feinberg School of Medicine of Northwestern University, Chicago, IL, ²Brigham and Women's Hospital, Boston, MA

PURPOSE

To describe the imaging characteristics of granulomas that form at the tip of intrathecal catheters which are used to administer morphine for pain relief.

MATERIALS & METHODS

Three patients with intrathecal catheters for morphine administration developed small masses at the catheter tip. Three patients underwent MR imaging with and without contrast whereas one patient underwent a noncontrast MR image of the spine. Images were obtained at 1.5 T with T1- and T2-weighted images as well as postcontrast T1-weighted images in the sagittal and axial planes. The clinical histories and pathology were reviewed and the imaging characteristics were tabulated.

RESULTS

In three patients, four granulomas formed at the intrathecal catheter tip during morphine administration. Three of the lesions were intrathecal and rounded in appearance while one of the lesions was elliptical in shape and inexplicably in the dorsal epidural space. All lesions were iso- to hyperintense on T1- and hypointense on T2-weighted sequences. After contrast administration, the predominant pattern was peripheral enhancement. All four lesions formed at the tip of the catheters and some resulted in cord compression and cord signal abnormality. Patient symptomatology included leg weakness, paresthesias, as well as bowel and bladder dysfunction. At surgery, the granulomas were markedly firm to the touch and some had a bluish-gray coating. The size of the lesions varied from 1.0 cm to 2.5 cm. Some of the granulomas were very adherent to the adjacent nerve roots, making total resection impossible without sacrificing some of the nerve roots. At pathology, the lesions were described as fibrous tissue with granulation tissue and cellular debris. No microorganisms were identified. AFB and fungal cultures were negative. The etiology of the granulomas is unknown although review of the literature suggests that the most likely cause is an inflammatory reaction to the administration of high dose intrathecal morphine. The silastic composition of the catheters is not felt to be responsible because this same catheter is used for intrathecal baclofen administration and no reports of granulomas have been described with the administration of this agent. However, the endhole morphology of the catheter may be a contributing factor, possibly resulting in a high local concentration of morphine.



CONCLUSION

Granulomas may form at the tip of intrathecal catheters used for morphine administration. These granulomas can act as space-occupying lesions that result in cord or cauda equina compression and cord signal abnormality. If not recognized, a vicious cycle of increasing neurologic symptoms followed by increasing morphine concentrations may ensue. A patient may complain of more pain only to be treated with a medication that is potentiating the problem. Although uncommon, early recognition of this entity is important and will result in improved patient care.

KEY WORDS: Granuloma, catheter, morphine

Paper 247 Starting at 11:34 AM, Ending at 11:39 AM

Postural Migration of Thickened Redundant Nerve Roots through a High-Grade Spinal Stenosis with Hip Flexion and Extension: A CT Myelographic Demonstration

Radaideh, M. M. • Walker, M. T. • Russell, E. J.

Northwestern Memorial Hospital
Chicago, IL

PURPOSE

Patients with high-grade lumbar spinal stenosis occasionally are observed to have thickened redundant nerve roots (TRNRs) superior to the level of stenosis. The theory behind this response is vascular compromise and friction neuritis that leads to swelling and inflammation of the nerve roots. It follows that with relief of the stenosis, the nerve roots will decrease in size. Rarely has the migration of TRNRs been demonstrated radiographically. The purpose of this report is to illustrate a case of migratory TRNRs on CT myelography (CTM) with hip flexion and extension and correlate this finding with the symptomatic relief these patients can get with postural changes.

MATERIALS & METHODS

A 56-year-old man presented with neurogenic claudication including low back pain, leg pain and progressive bilateral lower extremity weakness. His symptoms would become excruciating in the upright position and were partially relieved in the recumbent position with the hips flexed. Initial MR imaging demonstrated a high-grade spinal stenosis at L2-3 secondary to a disk bulge, ligamentous thickening, and facet hypertrophic degenerative changes. Immediately superior to the stenosis, a tangle of curvilinear structures were identified that represented TRNRs. To further define the stenosis, a CTM was performed. The injection was performed in the prone position below the level of the stenosis. Midway through the injection the patient experienced sudden exacerbation of his pain that required intravenous analgesics. At the conclusion of the injection, the patient immediately turned to the supine position and flexed his hips which helped alleviate some of his pain. CTM with the hips flexed showed the TRNRs below the stenosis. CTM with the hips extended, showed the TRNRs above the stenosis. A diagnosis of severe spinal stenosis with migratory TRNRs was made. The patient underwent a decompressive laminectomy and has made a remarkable recovery.

RESULTS

First described by Verbiest in 1953, TRNRs are the result of high-grade lumbar stenosis. Compression and motion of the nerve roots through the tight stenosis results in edema and inflammation of the leptomeningeal surface which produces elongated, swollen, serpigenous nerve roots. Symptoms are felt to be related to direct compression of the nerve roots, vascular compromise, and friction neuritis. MR imaging and CTM typically demonstrate TRNRs above the level of the stenosis. In our case, migration of the TRNRs was identified with hip flexion and extension. The patient's symptoms improved in the recumbent flexed position suggesting that the nerve roots were less compromised below the level of the stenosis.

CONCLUSION

Transient migration of TRNRs through a high-grade lumbar stenosis can occur with postural changes. Patients with neurogenic claudication secondary to severe lumbar stenosis often get at least partial symptomatic relief with hip flexion including sitting, squatting, and in the recumbent position with knees toward the chest. Symptomatic relief may be related in part to transient decompression of the spinal canal and positioning of the nerve roots below the stenosis.

KEY WORDS: Spinal stenosis, cauda equina redundant nerve roots

Paper 248 Starting at 11:39 AM, Ending at 11:44 AM

Rare Complication of Cervical Myelopathy Resulting from Calcium Pyrophosphate Dihydrate Deposition Disease

Srinivasan, A. • Belanger, E. • Goyal, M.

The Ottawa Hospital
Ottawa, ON, CANADA

PURPOSE

We wish to highlight the rare complication of cervical myelopathy resulting from calcium pyrophosphate dihydrate (CPPD) deposition in the cervical spine.

MATERIALS & METHODS

A 86-year-old female patient presented with a 6-month history of bilateral hand and foot numbness and diffuse weakness. Clinical examination revealed intact cranial nerves and decreased power in all muscle groups (Grade 3-4) with exaggerated tendon reflexes. There was also glove and stocking pattern of loss of truncal position, sense, and vibration. CT of the cervical spine revealed a large, slightly hyperdense mass showing multiple small calcifications in the anterior epidural space from the level of clivus superiorly to the lower third of C2 vertebra inferiorly. There was erosion of the dorsal portion of the dens with marked compression of the cord at C2 level. A subsequent MR image revealed the lesion to be isointense to muscle on T1- and T2-weighted images. In addition to compression of the cord there were changes of myelomalacia. Posterior decompression was performed and a biopsy of the epidural mass was obtained. The specimen showed robust calcium pyrophosphate crystal deposition with no evidence of neoplasm or inflammation.

RESULTS

CPPD deposition disease is an inflammatory arthropathy that is defined by the deposition of CPPD crystals in articular and periarticular structures which leads to characteristic chondrocalcinosis. It can occur independently or in association with any of a number of inflammatory or endocrine disorders. This form of crystal-induced arthritis tends to affect the peripheral joints, particularly the knees, ankles, shoulders, wrists, and second and third metacarpophalangeal joints, but involvement of the lumbar spine is not uncommon. Cervical spine disease due to CPPD deposition is, however, rare. There are only a few reported cases in the literature of cervical myelopathy resulting from CPPD deposition (1).

CONCLUSION

Since the diagnosis can be established preoperatively using distinctive imaging features and it is amenable to early surgical intervention, CPPD deposition disease should be considered in the differential diagnosis of masses of the cranio-cervical junction (2).

REFERENCES

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2. Zunkeler B, Schelper R, Menezes AH. **Periodontoid Calcium Pyrophosphate Dihydrate Deposition Disease: "Pseudogout" Mass Lesions of the Craniocervical Junction.** *J Neurosurg* 1996;85:803-809

KEY WORDS: CPPD, cervical, myelopathy

Thursday Morning

10:15 AM - 11:55 AM

Ballroom 6 A

**(54b) Interventional: New Devices
(Scientific Papers 249 - 260B)**

See also Parallel Sessions

(54a) Spine: Degenerative Disk Disease and Biomechanics

(54c) Adult Brain: Neoplasms

(54d) Spine: General, Spinal Cord

Moderators: Joseph M. Eskridge, MD
Gary R. Duckwiler, MD

Paper 249 Starting at 10:15 AM, Ending at 10:23 AM

Expandable Hydrogel-Platinum Coils: Indications, Technical Problems, and Complications in the Treatment of Cerebral Aneurysms

Fanning, N. F. • Brennan, P. • Thornton, J.

Beaumont Hospital
Dublin, IRELAND

PURPOSE

To present the initial experience of the use of the hybrid hydrogel-platinum coils (HydroCoil, MicroVention, Inc.) in the treatment of cerebral aneurysms in a single center. The indications, technical problems, and complications encountered are defined.

MATERIALS & METHODS

Prospective analysis of 40 patients with 40 cerebral aneurysms treated with 66 HydroCoil devices since they were first deployed in June 2003. Cases were evaluated at the time of coiling as to the indication for HydroCoil insertion, technical problems encountered and complications ensued.

RESULTS

HydroCoil devices were used in a total of 40 of 115 (35%) endovascularly treated cerebral aneurysms. Of note, our last 10 deployments were performed in the last 12 patients. Mean age at treatment was 55 years (range 32-76 years) with a female to male ratio of 28:12. Clinical presentation of this cohort included, subarachnoid hemorrhage (n = 25), mass effect (n = 3), regrowth of an aneurysm neck following previous coiling (n = 3), and incidentally found aneurysms (n = 9). Indications for deployment can be divided into three main groups based on aneurysm size: 1) to aid packing of large aneurysms (> 10 mm) in combination with detachable platinum coils (n = 16), 2) to complete coiling of small and medium sized aneurysms (3-10 mm) after formation of a basket with native platinum coils (n = 21), and 3) as the sole

treatment coil in small aneurysms (2-3 mm) ($n = 3$). HydroCoil devices led to increased percentage filling of the aneurysm compared to bare platinum coils. HydroCoil devices also facilitated using fewer coils to achieve good aneurysm occlusion in situations where there was catheter instability, vasospasm, or the need to preserve a vessel at the neck. Positioning the HydroCoil at the neck of the aneurysm did not seem to be associated with increased risk of parent vessel compromise. We encountered technical problems in 6 HydroCoil deployments (9%). In 3 patients we failed to satisfactorily position the HydroCoil in the aneurysm within the recommended 5 minute repositioning time limit. We encountered this problem in our first 10 patients and it was overcome by pretreating the HydroCoil with steam to soften the coil. Since this procedural modification we have not observed this difficulty, and it is now a standard part of the procedure. Other technical problems included, failure to track the coil through the microcatheter ($n = 2$), and premature detachment of a coil on attempted retrieval ($n = 1$). Both of these problems appear to relate to a certain fragility of the coil due to the unique construction method used. The premature detachment of the HydroCoil resulted in herniation of a trail of coil into the middle cerebral artery and a consequent dense hemiparesis in the patient. There were no other clinical complications.

CONCLUSION

While HydroCoil devices appear a very promising adjuvant to platinum coils in treatment of cerebral aneurysms, a number of technical difficulties still need to be overcome in its development. The precise role for this coil, whether used alone or in combination with standard coils, is evolving. Longer follow-up and further development is required.

KEY WORDS: Hydrocoil, aneurysm

Paper 250 Starting at 10:23 AM, Ending at 10:31 AM

First Year Single Center Experience with a New Nitinol Self-Expanding Microstent (Neuroform 1 and 2) for Cerebrovascular Applications: Technical and Short-Term Outcomes in 72 Stent Placements

Ugurel, M. S. • Beck, M. R. • Chaloupka, J. C. • Lee, S. • Tejada, J. G. • Hsu, S.

University of Iowa
Iowa City, IA

PURPOSE

We review our single institutional experience with the new nitinol self-expanding Neuroform (NF) microstent, in an attempt to evaluate the technical and short-term clinical efficacy of this device.

MATERIALS & METHODS

Over a 12-month period, $N = 72$ NF-1 or 2 microstents were used in $N = 63$ consecutive cases. Sixty patients were selected for treatment with a NF for the following indications: 1. stent-assisted remodeling (SAR) in $N = 58$ wide neck aneurysms, 2. stent-reconstruction of $N = 2$ fusiform aneurysms, 3. SAR of $N = 1$ iatrogenic carotid-cavernous fistula, and iv. SAR of $N = 2$ pseudoaneurysms/dissecting aneurysms. Several types of coaxial microcatheter techniques were utilized for bridging the targeted arterial seg-

ment (e.g., conventional and modified exchange, primary catheterization), and to deploy the stents (e.g., stabilizer, coil pusher, microguidewire).

RESULTS

With increasing experience there was substantial improvement in technical efficacy. During our first 31 cases, 61% of NF deployments were without any technical/clinical complications, whereas in the following 32 cases, the success rate increased to 94% (overall rate = 87.5%). Only 2 NFs could not be deployed owing to tortuous anatomy or inability of the catheter/stent to conform to the anatomy. Three NF misdeployments necessitated endovascular snaring to remove the stent from the targeted vasculature; 2/3 snared stents were retrieved successfully. In another 3 NF misdeployments, successful aneurysm neck bridging was attained by telescoping a second NF2. A wide range of anatomical sites of NF placement was possible, including the entire length of the internal carotid and basilar artery, anterior communicating complex, M1 and M2 segments of the MCA, and the A3 segment of the ACA. Technically adequate packing of coils was possible in 56/58 (96%) aneurysms after placement of the NF. Only one patient (1.7%) developed a serious clinical complication attributable to placement of the stent (delayed sylvian fissure hemorrhage from a presumed exchange guide wire perforation). Six-month follow-up angiographic results of this patient population will be provided.

CONCLUSION

Our experience with the NF1 and 2 microstents has been very favorable overall, although significant technical and clinical difficulties had been encountered initially during their initial use. Clearly, increasing cumulative experience, and recent technological and technical improvements have resulted in substantially improved technical outcomes that likely will translate into improving utility and effectiveness of this device.

KEY WORDS: Intracranial aneurysm, self-expanding stent, nitinol

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of: 1. Neuroform stent made by Boston Scientific Co. for cerebrovascular dissection and carotid-cavernous fistula.

The authors of this work have indicated the following affiliations/disclosures: 1. Boston Scientific Co.: Consultant, Research grant; 2. Cordis-Neurovascular: Consultant, Research grant; 3. Micrus: Consultant, Research grant.

Paper 251 Starting at 10:31 AM, Ending at 10:39 AM**Initial In Vivo Experience with a New Electrolytically Detachable Endovascular Stent System for Small and Tortuous Vessel Anatomy**

Doerfler, A. R.¹ • Becker, W.¹ • Wanke, I.¹ • Goericke, S.¹ • Monstadt, H.² • Forsting, M.¹

¹University of Essen, Essen, GERMANY, ²Dendron-MTI Bochum, Bochum, GERMANY

PURPOSE

To assess in vivo the mode of delivery, retrievability, short-term patency, and cellular response to a new flexible endovascular stent system in the rabbit. The stent is designed for delivery through a microcatheter and is fully retrievable with electrolytical detachment from a delivery wire.

MATERIALS & METHODS

We successfully deployed nine electrolytically detachable stents (range of sizes: 2.5-4 mm diameter, 15-35 mm length) in six straight (carotid) and three angled (subclavian) arteries of six Chinchilla Bastard rabbits. Serial imaging was performed using intravenous DSA (IV DSA), contrast-enhanced MRA (CE MRA), time of flight (TOF) MRA, and CT angiography (CTA) 3 days and 4 weeks after stent deployment, respectively. Subjects were sacrificed after 4 weeks (n = 5) and stents were removed for histologic analysis.

RESULTS

Stent deployment was technically feasible in all cases. After initial deployment all stents could be retrieved fully within the microcatheter. The detachment zone and the distal stent marker were visible easily under fluoroscopy; final detachment occurred reliably in all stents. We observed no procedural complications. Follow-up at 3 days and 4 weeks demonstrated all arteries patent and not narrowed, confirmed by histology. Noninvasive imaging using IV DSA, MRA, and CTA is feasible in this stent system, demonstrating CTA superior to MRA.

CONCLUSION

Our results demonstrate that this electrolytically detachable stent is promising as a stent for intracranial arteries since it can be delivered through microcatheters small enough for intracranial navigation. The stent is fully retrievable, thus providing greater control than currently available stents. CT angiography was superior to MRA in noninvasive imaging of the stent system and may be useful for follow-up. Further angiographic and histologic long-term data are necessary.

KEY WORDS: Stent, aneurysm, retrievable

Paper 252 Starting at 10:39 AM, Ending at 10:47 AM**Angioscopy-Guided Interventions: Initial In Vitro and In Vivo Evaluations**

Miskolczi, L. • Wakhloo, A. K.

University of Miami
Miami, FL

PURPOSE

During in vivo imaging sessions with our first angioscope several years ago, we realized the capabilities of direct endovascular visualization. After we improved visualization times from a few seconds to several minutes per session, it became possible to perform minor interventions while simultaneously observing with angioscopy. Our first system was not designed for guiding interventions, but our newest and improved angioscope was equipped with a 0.020" central channel for this purpose. With the new scope one of our goals was to evaluate how angioscopy can guide certain endovascular procedures, even if the technique does not promise to revolutionize interventional neuroradiology any time soon.

MATERIALS & METHODS

Our initial tests were carried out using a 3-French angioscope via an 8-French balloon-tipped guide catheter, which allowed a microcatheter to advance on the side of the scope within the guide. Our new scope is equipped with a center channel through which a microcatheter or other small devices can be advanced. In vitro tests were carried out in a plastic aneurysm model. The task was to visualize the aneurysm neck and manipulate the catheter tip and coil loops while coiling the aneurysm. In vivo, several tasks were performed with both the old and the new scopes. A small clot adherent to a freshly deployed stent was removed using endovascular forceps (Cook). The true lumen of a surgically dissected common carotid artery was accessed with a micro-guidewire in order to repair with angioplasty. In vivo aneurysm coiling also was performed using surgically created carotid artery sidewall aneurysms in dogs. After successful detachment, external manual compression to the neck was used to change the position of the coil mass to achieve partial protrusion towards the parent vessel. A micro-guidewire then was used under visual guidance to manipulate the coil mass back into the aneurysm by simply applying force with the wire tip in the desired direction. Angioscopy-guided stenting of a sidewall aneurysm was also attempted using a balloon-expandable device (INX, Medtronic-AVE).

RESULTS

Manipulation is easier and more accurate when performed via the center channel of the angioscope as opposed to a side-by-side configuration. All tasks except stenting were performed successfully. Angioscopy is not well suited for image-guided stent deployment in the configuration we used, as it makes positioning more complicated. Angioscopy increased the complexity of coiling procedures only minimally, but it provided valuable feedback on coil position. We found that angioscopy improved coil placement at the neck of the aneurysm when compared with fluoroscopy guidance.

CONCLUSION

Angioscopy is an excellent tool that provides a unique view of endovascular procedures, showing details that fluoroscopic guidance misses. Its direct visual feedback may result in better outcomes of certain procedures.

KEY WORDS: Angioscope, intervention

Paper 253 Starting at 10:47 AM, Ending at 10:55 AM

Endovascular Retrieval of Errant Platinum Coils during Treatment of Cerebral Aneurysms Using a Foreign Body Retrieval Device

Tong, F. C. • Cawley, C. M. • Abruzzo, T. A. • Dion, J. E.

Emory University School of Medicine
Atlanta, GA

PURPOSE

Damaged or suboptimally placed embolization coils can cause parent vessel compromise during endovascular aneurysm therapy. Common management strategies include permanent implantation of the coil, endovascular placement of a stent to pin the coil against the vessel wall, surgical retrieval, and endovascular retrieval of the coil using a snare. We describe three cases where a new endovascular retrieval device (Concentric Medical Retriever) was utilized to retrieve damaged or errant coils in aneurysm embolization procedures.

MATERIALS & METHODS

Three patients undergoing endovascular aneurysm embolization between December 2002 and August 2003 required coil retrieval. Patient #1 was a 47-year-old female with known occlusion of the right internal carotid artery and subarachnoid hemorrhage who underwent endovascular embolization of two right posterior cerebral artery aneurysms of the P1 and P2 segments. The distal aneurysm was embolized uneventfully. During embolization of the proximal aneurysm, one of the coils unraveled and detached into the parent vessel. Further manipulation of the microcatheter caused prolapse of the damaged coil into the right posterior communicating artery with flow limitation of the right anterior and middle cerebral arteries. An X4 Retriever was successfully utilized to remove the damaged coil. Patient #2 was a 59-year-old female undergoing coil embolization of an unruptured left ophthalmic artery aneurysm. A Boston Scientific Neuroform stent initially was placed across the aneurysm neck in the left internal carotid artery. A Microvention Hydrocoil became entangled during repositioning and unraveled and fractured as it was being withdrawn. An X5 Retriever was deployed and the coil was removed. Patient #3 had undergone successful coil embolization of an unruptured right ophthalmic artery aneurysm and developed a new left pronator drift and mild left upper extremity weakness during overnight observation. Follow-up angiography demonstrated delayed ejection of a Hydrocoil into the left middle cerebral artery with endoluminal thrombus at the bifurcation. An X5 Retriever was deployed adjacent to the coil and the coil was removed successfully.

RESULTS

The damaged or errant coils were removed entirely in all three patients. Follow-up angiography demonstrated vasospasm in Patient #2 which subsequently resolved. There was no angiographic evidence of subsequent vessel damage in any of the patients. All of the patients remained at their neurologic baseline immediately following coil retrieval.

CONCLUSION

Parent vessel compromise from damaged or errant coils can occur during endovascular aneurysm therapy. The Concentric Retriever successfully removed coils in all three patients in which retrieval was attempted. There were no complications associated with the retrieval procedures.

KEY WORDS: Coil retrieval, aneurysm

The authors of this work have indicated the following affiliations/disclosures: Concentric Medical Corp.: Scientific advisory board.

Paper 254 Starting at 10:55 AM, Ending at 11:03 AM

Idiopathic Intracranial Hypertension: Preliminary Experience of Two Cases Treated by Venous Sinus Stenting

Garg, A. • Gaikwad, S. B. • Mishra, N. K. • Gupta, V.

All India Institute of Medical Sciences
New Delhi, INDIA

PURPOSE

Idiopathic intracranial hypertension (IIH) is a condition characterized by raised intracranial pressure in the absence of intracranial pathologic findings. The high pressures documented in the intracranial venous sinuses in IIH could be the result of focal stenotic lesions in the lateral sinuses obstructing cranial venous outflow. We report our preliminary experience of 2 cases of endoluminal venous stent placement as a treatment for IIH.

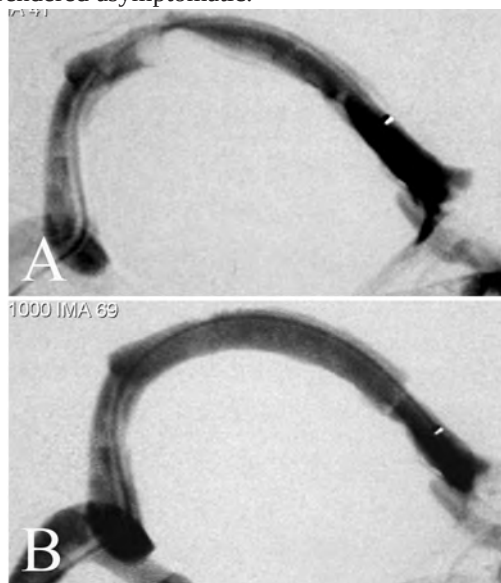
MATERIALS & METHODS

We report 2 patients with IIH who were evaluated for venous sinus disease and treated with endoluminal stent placement in the stenotic sinus. Case 1: A 35-year-old female presented with holocranial, nonthrobbing headache for last 5 years which has aggravated in last 15 days. She also had symptoms of transient visual obscuration and 6 episodes of facial deviation for last 5 months. On examination, she had advanced bilateral papilledema and left ptosis. Her visual acuity was 6/6 in both eyes. The CSF pressure was 250 mm of CSF on lumbar puncture with normal composition. MR examination showed empty sella. Postgadolinium MRV showed bilateral transverse sinuses stenosis. IADSA confirmed bilateral transverse sinus stenosis, the right being dominant (Figure 1A). The pressure gradient was 15 mm of Hg (25/10) across the stenosis. Under general anesthesia, an 8-29 mm monorail wallstent was placed across the right transverse sinus stenosis (Figure 1B). The pressure gradient was reduced to 4 mm of Hg (14/10) poststent placement. Repeat CSF showed the pressure of 75 mm of CSF. The patient currently is asymptomatic after 6-month follow-up. Case 2: A 46-year-old female admitted with 1-year history of right hemispheric headaches which had exacerbated since last 1 month. She had visual blurring of left eye for last 4 months. She was diagnosed to

have hypothyroidism 3 years earlier, which was well controlled on drugs. Examination showed bilateral papilledema and enlarged blind spot in left eye. Her visual acuity was normal. Her thyroid functions were normal. MR images revealed an empty sella. IADSA showed bilateral transverse sinus stenosis, the right being dominant. A 6-17 mm express SD stent placed across the stenosis. Present pressure gradient was 21 mm of Hg (30-9), which reduced to 3 mm (16-13) following stent placement. Postprocedure, the patient's headache was reduced markedly.

RESULTS

Intrasinus pressures were reduced by stenting. Both patients were rendered asymptomatic.



CONCLUSION

The importance of venous sinus disease in the etiology of IIH is probably underestimated. Lateral sinus stenting shows promise as an alternative treatment to neurosurgical intervention.

KEY WORDS: Idiopathic intracranial hypertension, venous sinus, stenting

Paper 255 Starting at 11:03 AM, Ending at 11:11 AM

In Vivo Evaluation of Endovascular Devices: A New Application of Angioscopy

Miskolczi, L. • Gounis, M. J. • Onizuka, M. • Perlow, A. • Cesar, L. • Lieber, B. B. • Wakhloo, A. K.

University of Miami
Miami, FL

PURPOSE

As implantable devices get smaller, it becomes more difficult to get reliable information of their behavior in vivo. The gold standard method is histology, which requires a terminal procedure. After positive initial experiences with angioscopy - a minimally invasive technique, reported at the WFITN meeting in Recife, Brazil - we decided to further pursue this approach. Our goal is to have angioscopy accepted as a standard method for in vivo testing of endovascular devices.

MATERIALS & METHODS

Twenty-eight sidewall aneurysms were created in the carotid arteries of 13 dogs. Using a custom-built fiberoptic device, angioscopic observations were conducted with proximal flow protection and slow saline infusion. Three types of platinum detachable coils and 2 types of intracranial stents were evaluated. A total of 33 angioscopic procedures were performed to visualize the following: 11 coiled aneurysms, 16 coiled and stented aneurysms, 1 untreated aneurysm; 5 aneurysms were observed twice, at 3 and at 6 months. Eight of the angioscopic procedures were done immediately after device implant, the rest at 1-, 3- or 6-month follow-up. We compared our findings to histology in nonsurvival cases. Our angioscope has 8000 imaging fibers, 200 illumination fibers, 2-way steering at the tip, a 6-French outer diameter and a 0.020" center channel.

RESULTS

All 33 angioscopic procedures were successful, although we had initial difficulties with proximal flow control in 8 cases. In 2 of the 11 aneurysms, angioscopy revealed a small aneurysm remnant missed by digital subtraction angiography (DSA) but confirmed later with histology. In 9 of the 16 stent-and-coil cases, angioscopy showed minor irregularities of stent struts. Seven of these were missed completely by DSA. In the remaining 2 cases an irregularity was suggested by angiography but details could not be obtained with our Siemens Angiostar DSA. The image quality of the angioscope allowed us to visualize a 0.009" red clot attached to a specific spot of the detachment zone of a recently detached coil, and we could spot an approximately 0.012" gap between a filament of a recently deployed balloon-expandable stent and the wall of the parent vessel. After calibrating tissue coverage on metal structures to matching histology cross-sections, we now are capable of estimating neointimal thickness in the 0 to 200 micron range.

CONCLUSION

Our technique is unique in providing direct, high-resolution, extended duration, color endovascular visualization of the target objects. The fact that angioscopy detects device irregularities where DSA (or really any other imaging method) does not, can be frustrating. On the other hand, engineers can benefit from early detection of such problems. Our method is especially suitable for the evaluation of clot formation or neointimal growth on stent struts, which - considering the recently revealed clotting issues with coated coronary stents - could be of great interest.

KEY WORDS: Angioscopy, stent, coil

The authors of this work have indicated the following affiliations/disclosures: 1. Micrus Corporation: Research grant; 2. Cordis/Johnson and Johnson: Business relationship, consulting, research grant; 3. Micro Therapeutics, Inc.: Business relations, consulting; 4. Boston Scientific Corporation: stock options, research grant.

Paper 256 Starting at 11:11 AM, Ending at 11:19 AM**Useful on Partial Aortic Obstruction of Symptomatic Vasospasm: NeuroFlo™ Catheter**

Miranda, C.^{1,2} • Vila, J.¹ • Ferrario, A.¹ • Doroszuk, G.¹ • Barbut, D.¹ • Lylyk, P.¹

¹ENERI, Buenos Aires, ARGENTINA, ²FLENI, Buenos Aires, ARGENTINA

PURPOSE

The aortic obstruction increases cerebral blood flow (CBF) and reduces infarct volume in animals. We also have reported on flow augmentation in patients with stroke or vasospasm using a novel endovascular dual balloon device (NeuroFlo™, CoAxia™, Maple Grove, MN). We now report our results of a safety study of controlled aortic obstruction with the same device in patients with symptomatic vasospasm following aneurysmal subarachnoid hemorrhage in a single center.

MATERIALS & METHODS

The NeuroFlo catheter was placed transfemorally in the descending aorta with one balloon positioned below and one above the renal arteries. The balloons were inflated sequentially to a predetermined obstruction level as dictated by the protocol in 20 patients with symptomatic vasospasm. Aneurysms were secure prior to the procedure. Regional perfusion was assessed angiographically and procedural response and outcome were assessed at 1 month using the NIHSS and Modified Ranking Scale.

RESULTS

Thirteen females and 7 males were enrolled. Mean age 41 years. Perfusion deficits improved during the procedure in 18 patients. Sixty percent of the patients had clinically significant improvement (NIHSS > 2 points in 24 hours after the procedure). Furthermore, procedural response was highly predictive of outcome at 1 month. NIHSS did not increase in any patient during the procedure and the functional independence were obtained in 55% of cases. There were no procedure-related complications. Mortality related to the procedure was 0% and global mortality was 15%.

CONCLUSION

Partial aortic obstruction like a new treatment for symptomatic vasospasm, showed to be safe and and effective to improve cerebral perfusion with a secondary clinical benefit in this group of patients.

KEY WORDS: Vasospasm, SAH, cerebral blood flow

Paper 257 Starting at 11:19 AM, Ending at 11:27 AM**Three-Dimensional Digital Angiography and Fusion Digital Subtraction Angiography: Two New Reconstruction Algorithms for Simultaneous Three-Dimensional Rendering of Osseous and Vascular Information Obtained during Rotational Angiography. I. Technical Aspect**

Oishi, S.¹ • Murphy, K. P. J.² • Gailloud, P.²

¹Toshiba Medical Systems Research and Development Center, Tochigi, JAPAN, ²The Johns Hopkins Medical Institutions, Baltimore, MD

PURPOSE

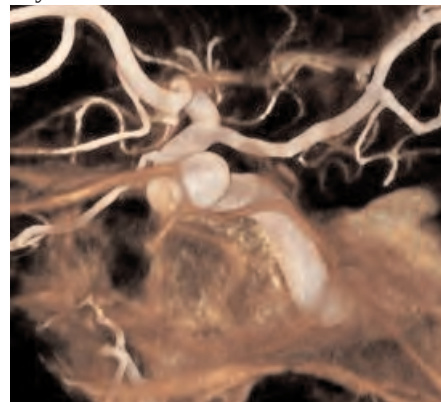
To describe two reconstruction algorithms that provide simultaneous three-dimensional imaging of bone and blood vessels.

MATERIALS & METHODS

Two algorithms that can build three-dimensional vascular and osseous data sets from standard catheter rotational angiograms are described: (1) Three-dimensional digital angiography (3D-DA) reconstructs a nonsubtracted angiogram in a single three-dimensional representation of the blood vessels and surrounding bony structures; (2) Three-dimensional fusion digital angiography (3D-FDSA) is based on separate reconstructions of the mask and contrast sequences of the rotational acquisition. The two independent three-dimensional data sets (3D-bone and 3D-DSA) then are fused in a single three-dimensional representation. Both algorithms use a modification of the Feldkamp method that compensate for the signal inhomogeneity inherent to the reconstruction of nonsubtracted rotational acquisitions. The three-dimensional data set is postprocessed using a commercially available computer workstation.

RESULTS

Both algorithms successfully build three-dimensional data sets that combine vascular and osseous information. Three-dimensional digital angiography allows evaluating the topographic relationships between the blood vessels and their bony surroundings (Figure). However, since 3D-DA is based on the reconstruction of a single nonsubtracted rotational data set, it cannot avoid an artifactual loss of image quality when osseous and vascular structures are immediately adjacent, such as at the skull base. Three-dimensional fusion digital angiography separately reconstructs the osseous and vascular information obtained from the rotational angiogram, keeping optimal angiographic resolution and offering precise topographic analysis even when vessels are in contact with bone.



CONCLUSION

We report two reconstruction algorithms that offer simultaneous three-dimensional display of the osseous and vascular information obtained by rotational catheter angiography.

KEY WORDS: Cerebrovascular imaging technique, technical development, three-dimensional angiography

The authors of this work have indicated the following affiliations/disclosures: Toshiba Medical Systems: full-time employment.

Paper 258 Starting at 11:27 AM, Ending at 11:35 AM**Endovascular Treatment of Recanalized Cerebral Aneurysms Using Matrix Coils**

Biondi, A. • Bonneville, F. • Jean, B. • Sourour, N. • Boch, A. L. • Chiras, J.

Pitié-Salpêtrière Hospital - University Paris VI
Paris, FRANCE

PURPOSE

Aneurysm recanalization is still a major limitation of current bare coil therapy. It preferentially occurs in case of large or giant aneurysms with wide neck or with incomplete initial occlusion. The Matrix coils are covered with a bioabsorbable polymeric material which increases the amount of mature intraaneurysmal connective tissue and the neck tissue thickness. This system might prevent aneurysmal recanalization after endovascular treatment. The purpose of this study was to evaluate the midterm efficacy of Matrix coils in recanalized cerebral aneurysms which were treated previously with regular bare coils.

MATERIALS & METHODS

A retrospective study was carried out on 12 patients (5 woman, 7 men, mean age: 45 years) treated with Matrix coils for a cerebral aneurysm which was embolized previously with regular bare coils. Six aneurysms were small (<10 mm) and six large (>10 mm); ten lesions had a wide neck (> 4 mm); nine bled and three were unruptured. Occlusion was considered initially as total or subtotal (> 95%) in all cases except one. All patients subsequently have been treated with Matrix coils of their recanalized cerebral aneurysm after informed consent. Clinical and angiographic follow-up (at 3 or 6 months) was available in all cases.

RESULTS

Complete occlusion was achieved in 11 aneurysms and subtotal (> 95%) in one. No complication occurred during the procedure. At angiographic follow-up, no aneurysm recanalization or stenosis/occlusion of the parent artery was observed. Patients presented no clinical complication in the follow-up period.

CONCLUSION

Preliminary results show that Matrix coils can be used efficiently in the occlusion of recanalized cerebral aneurysms. Further follow-up studies are needed in order to evaluate the long-term stability of the aneurysm occlusion.

KEY WORDS: Aneurysm, matrix coils, recanalization

Paper 259 Starting at 11:35 AM, Ending at 11:40 AM**Emergency Repair of an Iatrogenic MCA Dissecting Aneurysm after Angioplasty Using the Neuroform Self-Expanding Microstent**

Tejada, J. G. • Chaloupka, J. C. • Lee, S. K. • Ugurel, M. S. • Hsu, S. W.

University of Iowa
Iowa City, IA

PURPOSE

Emergency repair of an iatrogenic MCA dissecting aneurysm after angioplasty using the Neuroform self-expanding microstent.

MATERIALS & METHODS

Case report: A 51-year-old man presented with new right hemispheric transient ischemic attacks (left-sided hypesthesia and weakness), despite double oral antiplatelet therapy. An MR angiography (MRA) showed a severe stenosis of the M1 segment of the MCA, which was confirmed on catheter angiography. Percutaneous transluminal angioplasty (PTA) was performed using a 2 x 9 mm coronary microballoon catheter, which was technically successful and clinically uncomplicated. The patient was continued on double antiplatelet therapy and did well with cessation of TIAs, until 1 week later when he developed severe bifrontal headaches. Emergency angiography showed a large intimal flap with an inferior saccular false channel of the previously angioplastied right M1 segment, consistent with a delayed iatrogenic dissection and associated pseudoaneurysm formation. Owing to the very small diameter of the normal M1 segment (approximately 2 mm) and the presence of a pseudoaneurysm resulting in severe headaches, we were reluctant to try using the smallest available coronary balloon expandable stent (2.5 mm in diameter) to repair the dissection. We instead elected to use the recently available self-expanding microstent [Neuroform (NF) 1], which was transferred via back-loading into a Renegade Hi-Flo microcatheter. The stent was positioned easily and deployed across the dissected segment, resulting in immediate tacking down of the intimal flap and markedly reduced filling of the inferior pseudoaneurysm. A 6-week follow-up angiogram showed complete healing of the dissection/pseudoaneurysm.

RESULTS

Endovascular approaches to intracranial revascularization using PTA or stent-assisted PTA (SAPTA) is becoming increasingly utilized at many centers, owing to significant improvements in technique, technology, and peri-operative adjunctive management. However, major complications, such as dissections with or without pseudoaneurysm formation still occur. Conventional management options include conservative/supportive treatment vs SAPTA. However, the latter approach may be technically difficult/impossible owing to various anatomical constraints (e.g., size of the target artery, tortuosity of vasculature), and also carries increased risk of rupture with catastrophic hemorrhage when using a balloon-expandable coronary stent. Recently, the new self-expandable NF has become available by HDE approval for the adjunctive treatment of wide-neck intracranial aneurysms. Owing to the use of ultrafine nitinol filaments configured in an open cell design, the NF is highly flexible and readily deliverable through a conventional

braided microcatheter, permitting easier distal IC access. However, the NF intrinsically has a relatively modest radial force, which may not be ideal for use in revascularization approaches. Therefore its efficacy for such applications up until this time has not been evaluated.

CONCLUSION

To our knowledge our case represents the first successful repair of an iatrogenic IC artery dissection after PTA using the new NF micro-stent. Despite the relatively low radial force produced by the NF, our case illustrates the feasibility of using this stent for the treatment of IC arterial dissections.

REFERENCES

1. Broadbent LP, Moran CJ, Nehra A, Cross Dewitt T, Derdeyn CP. **Transfer of a Self-Expanding Stent to a Braided Microcatheter with the Aid of Transcatheter Illumination: Technical Report and Illustrative Case.** *AJNR Am J Neuroradiol* 2003;24:1517-1519

KEY WORDS: Angioplasty, complications, stents

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of a Neuroform stent made by Boston Scientific. for MCA dissection treatment.

The authors of this work have indicated the following affiliations/disclosures: 1. Boston Scientific: Consultant; 2. Cordis Neurovascular: Stents; 3. Micro Therapeutics, Inc.: Consultant.

Paper 260 Starting at 11:40 AM, Ending at 11:45 AM

A Triaxial Catheter System for Spinal Vascular Interventions: Technical Note

Garg, A. • Gupta, V. • Mishra, N. K. • Gaikwad, S. B.

All India Institute of Medical Sciences
New Delhi, INDIA

PURPOSE

Endovascular treatment is mainstay in the treatment of spinal cord vascular malformations (SCVMs). However, in some cases the feeding artery may have long and tortuous course, making navigation of microcatheters difficult. As a rule, the longer, the smaller in diameter, and the more tortuous the segment to be traversed by the microcatheter is, the more sites there are for friction between the microcatheter and vessel wall. We describe a "triaxial" catheter technique in the treatment of SCVMs, which proved to be very helpful in catheter navigation.

MATERIALS & METHODS

Under general anesthesia, spinal angiograms were performed in five patients (age: 21-35 years, M:F- 4:1). The SCVMs were localized in lower dorsal or lumbar regions. The feeding arteries were arising either from intercostal artery (2) or lumbar arteries (3). The intercostal/lumbar artery supplying the spinal vascular malformation was catheterized with RC1/ RC2/cobra catheter, which was exchanged with Tracker 38 (105 cm) placed inside a single curve renal guiding catheter. The renal guiding catheter was placed at the origin of intercostal/lumbar artery and Tracker

38 was advanced until the origin of feeding radicular artery. Through Tracker 38, microcatheters were navigated. This system ensured stability of guiding catheter with good pushability of the microcatheter. Description of the Catheter System: Tracker-38 (Target Therapeutics, Fremont, CA) was a single hole infusion catheter with outer diameter of 5.3F/5F and the inner diameter of 1.02 mm (0.040 in). The catheter accepted a 0.038" guidewire. There were two catheter lengths - 105 cm and 120 cm. Renal guiding catheter- Mach 1 (FR 3.5) (Boston Scientific Scimed, Inc. Maple Grove, MN), internal diameter - 0.070", length 60 cm. Microcatheter - Ultraflow, Prowler (165 cm).

RESULTS

We were able to navigate the microcatheter in all cases without much difficulty. No evidence of thrombo-embolism or spasm was seen.

CONCLUSION

Triaxial technique is very helpful for the catheterization of spinal vascular malformations in appropriate cases.

KEY WORDS: Spinal cord vascular malformations, triaxial technique, embolization

Paper 260A Starting at 11:45 AM, Ending at 11:50 AM

Mandible Arteriovenous Malformations

Yakes, W. F.

Vascular Malformation Center
Englewood, CO

PURPOSE

To determine optimal management strategies for the treatment of mandibular AVM.

MATERIALS & METHODS

Six patients (all females), age 9 -14 years; mean age 12, underwent endovascular therapy to treat their mandibular AVMs. Five patients had distinct intraosseous AVM and one patient had periosteal mandibular AVM. Three patients had prior PVA and gel foam embolization, one patient had a lip graft, one had prior mandible surgery, all that had failed.

RESULTS

All six patients have demonstrated MR and angiographic cure of their AVM. The follow-up is 11-35 months, with a mean follow-up of 18 months. No complications were noted.

CONCLUSION

Endovascular approaches to manage mandibular AVM are curative. The intraosseous variety is largely a fistula between artery and vein within the bone. All respond well to endovascular ethanol therapy alone. Surgery was not required in any patient.

KEY WORDS: AV malformation, mandible, ethanol

The author of this work has indicated the following affiliations/disclosures: Micrus Corporation: Board member.

Paper 260B Starting at 11:50 AM, Ending at 11:55 AM**Ethanol and Coil Embolization of Complex Dural Arteriovenous Malformation**

Yakes, W. F.

Vascular Malformation Center
Englewood, CO

PURPOSE

To evaluate the efficacy of ethanol as well as ethanol and coils in the management of complex dural AVF.

MATERIALS & METHODS

Thirteen patients (mean age 39 years; 8 females, 5 males). All patients presented with dural AVF involving the transverse sinus, sigmoid sinus and cavernous sinus. One patient suffered from high output cardiac state due to the massive size of her combined dural fistula and scalp AVM. All patients underwent MR and cerebral arteriogram evaluations. Patients underwent ethanol embolization, coil embolization, or ethanol and coil embolization in combination. These acquired AVF were nontraumatic.

RESULTS

Twelve of thirteen patients were endovascularly cured of their disease at a mean follow-up of 5 months. One patient's therapy is on-going. In those patients who had thrombosed sigmoid sinuses and partially thrombosed transverse sinuses with venous drainage being cortical because of the occluded sinuses, novel approaches were utilized to reach the point of fistualization and treated with coils and ethanol. Sacrifice of the diseased transverse and sigmoid sinus was utilized also to treat the large dural AVF involving these segments. In the cavernous sinus only coil embolization was utilized. In those patients presenting the pulsatile tinnitus, it was absent at follow-up. Headaches also resolved. Except for one patient with a transient homonymous hemianopsia, no other complication occurred. One patient's therapy is on-going.

CONCLUSION

Complex acquired dural AVF can be treated by endovascular means. Complications can be avoided with meticulous technique.

KEY WORDS: Dural AVF, ethanol, coils

The author of this work has indicated the following affiliations/disclosures: Micrus Corporation: Board member.

Thursday Morning

10:15 AM - 11:45 AM

Room 606 - 609

**(54c) Adult Brain: Neoplasms
(Scientific Papers 261 - 271)**

See also Parallel Sessions

(54a) Spine: Degenerative Disk Disease and Biomechanics

(54b) Interventional: New Devices

(54d) Spine: General, Spinal Cord

Moderators: Danielle Baleriaux, MD
Bruce A. Wasserman, MD

Paper 261 Starting at 10:15 AM, Ending at 10:23 AM**Clinical and Imaging Spectrum in a Large Series of Anaplastic Oligodendrogliomas**

Litzau, D. W.¹ • Litzau, D. W.¹ • Salzman, K. L.¹ • Osborn, A. G.¹ • Blumenthal, D.¹ • Koeller, K.²

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PURPOSE

The World Health Organization (WHO) classification of brain tumors recognizes two types of oligodendroglial tumors: oligodendroglioma (WHO Grade 2) and anaplastic oligodendroglioma (AO) (WHO Grade 3). These tumors differ genetically and in treatment response from diffuse astrocytomas. The imaging findings of oligodendroglioma are well characterized. However, only a few scattered case reports and small series have reported imaging findings of AOs. We examined the imaging features and clinical presentation in patients with documented AOs in an attempt to characterize patterns that might define accurate preoperative diagnosis.

MATERIALS & METHODS

Thirty-three patients with pathologically proven AOs from two institutions were reviewed retrospectively. MR studies were evaluated for tumor location, margins, signal characteristics, cystic and/or hemorrhagic components as well as pattern, intensity, and location of contrast enhancement. CT studies were evaluated for calcification, hemorrhage, bone changes, density, and enhancement characteristics. Clinical information reviewed included age at presentation, gender, and presenting symptoms. Pathologic correlation was reviewed in all cases.

RESULTS

There were 20 female and 13 male patients. The age at presentation ranged from 8 years to 73 years with mean age at initial diagnosis of 38.5 years. The most common presenting features were headache (54%) and focal neurologic deficit (35%). AOs are predominantly infiltrating tumors (31/33) and show hypointense T1 and hyperintense T2 signal in all MR imaging cases (27/33). Of the enhancing tumors (21/27), the most common contrast enhancement pattern was punctate/patchy (47%). Enhancement intensity was typically minimal (63%) and central (52%). Six cases (22%) showed no enhancement. The most common tumor location was the frontal lobe (67%) with unilateral frontal lobe involvement seen in 42%. CT revealed calcification in 10 tumors and calvarial erosion in 3 patients. Hemorrhage was seen in 7 tumors.

CONCLUSION

The imaging spectrum of AOs is much broader than expected. Although a characteristic imaging appearance is seen in the majority of cases, 22% showed no enhancement, similar to low grade gliomas. Sixteen percent had a necrotic-appearing center with intense rim enhancement, indistinguishable from classic primary glioblastoma multiforme. We conclude that while there are no specific imaging criteria that identify AOs preoperatively, an infiltrating mass in the frontal lobe that demonstrates minimal patchy/punctate central enhancement strongly suggests the diagnosis.

KEY WORDS: Oligodendroglioma, MR imaging

Paper 262 Starting at 10:23 AM, Ending at 10:31 AM

Lactate-Edited MR Spectroscopy Imaging: Increased Lactate in High Grade Gliomas Prior to Radiotherapy Correlates with Treatment Failure

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PURPOSE

Although advances have been made in the diagnosis and treatment of high grade gliomas, the prognosis remains dismal. Treatment must attempt to balance prolonged survival with quality of life. As such, identifying factors predictive of early treatment failure could aid in patient counseling and potentially warrant more aggressive measures. Proton MR spectroscopic imaging (MRSI) is used commonly for characterization of gliomas, and an increased tumor lactate/ -acetylaspartate ratio has been reported to correlate with shorter survival (1). We hypothesized that lactate also may serve as a predictor of tumor progression during treatment and undertook evaluation with serial lactate-edited MRSI.

MATERIALS & METHODS

Eleven patients without prior treatment or biopsy were diagnosed with gliomas (n = 2, Grade III; n = 9, Grade IV) and were included. In addition to preoperative imaging, the patients were evaluated immediately prior to and following postoperative radiotherapy. Specifically, these assessments each consisted of conventional MR imaging and MRSI. The amount of residual enhancing tumor was determined pre and

postradiotherapy, and patients were grouped as treatment responders (stable or decreased tumor) or treatment failures (increased tumor). The MRSI protocol included 3D J-difference lactate-edited MRSI using point resolved spectral selection (PRESS) volume selection that incorporated a two-cycle band selective inversion with gradient dephasing (BASING) pulse (2). Lactate was quantified as previously described (3), and lactate content of the resection cavity was excluded. Comparison of lactate on the basis of treatment response was undertaken with the Mann-Whitney U test.

RESULTS

All patients underwent attempted gross total tumor resection. The intervals (mean $\pm$ standard deviation) between preoperative and preradiotherapy imaging and between pre and postradiotherapy imaging were 31 ± 15 days and 62 ± 12 days respectively. Five patients were treatment responders (3 stable, 2 decreased residual tumor), and six patients represented treatment failures. Preoperatively, the maximum lactate (median) ranged from 4.73 to 19.37 (10.82) in treatment failures and 6.22 to 51.54 (13.59) in responders ($p = 0.273$). Prior to radiotherapy, the maximum lactate ranged from 4.55 to 13.01 (6.68) in treatment failures and 1.49 to 5.70 (4.97) in responders ($p = 0.045$).

CONCLUSION

Lactate-edited MRSI is feasible for the serial study of high grade gliomas. Patients with disease progression during treatment demonstrated increased tumor lactate immediately prior to radiation therapy. In contrast, treatment response was independent of preoperative lactate levels. These preliminary results warrant further study in larger populations with inclusion of additional measures of clinical outcome.

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KEY WORDS: Glioma, lactate, MR spectroscopy

Paper 263 Starting at 10:31 AM, Ending at 10:39 AM**Grading Brain Tumors Using Combined Dynamic Susceptibility Contrast MR Imaging Perfusion Parameters and Nearest Neighbor Analysis**

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PURPOSE

The purpose of this study was to use combined dynamic susceptibility contrast (DSC) MR imaging perfusion parameters and nearest neighbor analysis to grade brain tumors.

MATERIALS & METHODS

Over 200 DSC perfusion studies have been performed to date, with informed written consent, under guidelines approved by the Institutional Review Board at our institution. We have completed the perfusion analysis on 28 of these patients, which consisted of 16 confirmed high grades (WHO grade IV) and 12 low grades (WHO grades II and III). Gradient-echo (GE) and spin-echo (SE) cerebral blood flow (CBF), volume (CBV), mean transit time (MTT) and the ratio (DR2*/DR2), which is a measure of mean vessel diameter, were measured using a simultaneous GE/SE EPI perfusion scan on a 1.5 T scanner (1, 2). Data was extracted from ROIs of the whole tumor (avoiding areas of necrosis) and contralateral brain. All results are normalized to contralateral brain. Brain tumor perfusion is known to be highly heterogeneous and doesn't exhibit unidirectional (i.e., always higher than contralateral tissue) shifts that would lend itself to typical thresholding techniques such as ROC analysis. The nearest neighbor analysis only assumes that the perfusion parameters of tumors of the same grade will be clustered together in parameter space. The nearest neighbor approach assigns the tumor grade based on the grades of the parameters nearest to the subject of interest. For this study the assignment was based on the three nearest subjects. Nearest neighbor analysis was used to determine which combination of these 7 parameters gave the most reliable prediction of tumor grade.

RESULTS

The individual GE CBF, CBV, and MTT were more predictive of tumor grade than SE CBF, CBV, and MTT values. The ratio values alone correctly assigned the tumor grades of 71% of the 28 patients. The combination of the ratio values and the GE CBV gave the most reliable prediction (75% correct). The addition of the CBF and MTT parameters always reduced the reliability of the test.

CONCLUSION

Even with the small training data set of 28 subjects the nearest neighbor analysis of combined DSC MR imaging perfusion parameters indicated its potential to determine tumor grade correctly predicting the tumor grade with 75% precision. It is expected that the predication reliability will improve as the number of subjects included in the study increases. Since CBF and MTT are very heterogeneous both within and across tumors it is expected that the size of the training data set must be substantially larger to establish tumor grade clusters of these parameters. To establish the

clinical relevancy of this analysis future studies include sensitivity and specificity tests and a comparison with thresholding techniques.

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KEY WORDS: Brain tumors, dynamic susceptibility contrast, tumor classification

The authors of this work have indicated the following affiliations/disclosures: National Institutes of Health/National Cancer Institute: CA082500.

Paper 264 Starting at 10:39 AM, Ending at 10:47 AM**Comparison of Endothelial Permeability Surface Area Product, ktrans, Derived by Steady-State T1 and First-Pass T2* Methods for Brain Tumors**

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PURPOSE

Endothelial permeability of vessels within brain tumors provides important information about the nature of neovascularization and blood-brain barrier integrity. The conventional steady-state contrast-enhanced T1-weighted method of determining endothelial permeability surface area product, ktrans, is limited by long scanning times, complex postprocessing algorithms, and over or underestimation of ktrans (1, 2). The aim of this study was to correlate ktrans derived by steady-state T1- with first-pass T2*-weighted methods in brain tumors.

MATERIALS & METHODS

Twenty-seven patients with treatment-naïve gliomas or meningiomas were studied prior to surgery. ktrans was derived from both dynamic contrast-enhanced steady-state T1-weighted spoiled gradient-recalled (SPGR) and dynamic first-pass T2*-weighted sequences performed 30 minutes after the first injection of gadolinium. Uniform 5 mm diameter regions of interest within each tumor were drawn and saved on the postcontrast 3D SPGR image. Two investigators independently measured ktrans from the steady-state T1 acquisitions using an algorithm based on the unidirectional model and from the first-pass T2* acquisitions using an algorithm which assumes that contrast agent exists in two interchanging compartments (plasma and extravascular extracellular space) (3). ktrans was derived by estimating vascular contrast agent concentration from normal white matter and fitting it to the expression for the tissue concentration.

RESULTS

All meningiomas (n = 7) and grade IV gliomas (n = 10) enhanced on postcontrast 3D SPGR images; only 3 of 10 grade I-III gliomas enhanced. There was good linear correlation between ktrans for gliomas ($R^2 = 0.91$; Figure-top), but not for meningiomas (Figure-bottom), calculated using the steady-state T1 and the first-pass T2* techniques.

Diffusion Tensor Imaging and 1H Spectroscopy in Characterization of Primary Brain Tumors

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PURPOSE

Diffusion tensor imaging (DTI) is widely used to map white matter tracts in normal brain. Two parameter maps obtained with DTI: mean diffusivity (MD) and fractional anisotropy (FA) give additional information concerning tissue microstructure. 1H spectroscopy reveals tissue physiology and metabolism. Both methods are useful in oncological surgery planning giving information of tumor malignancy (spectroscopy), degree of tissue edema, displacement of white matter (WM) tracts and infiltration (DTI). Goal of this study was to determine usefulness of different parameters in determining tumor malignancy.

MATERIALS & METHODS

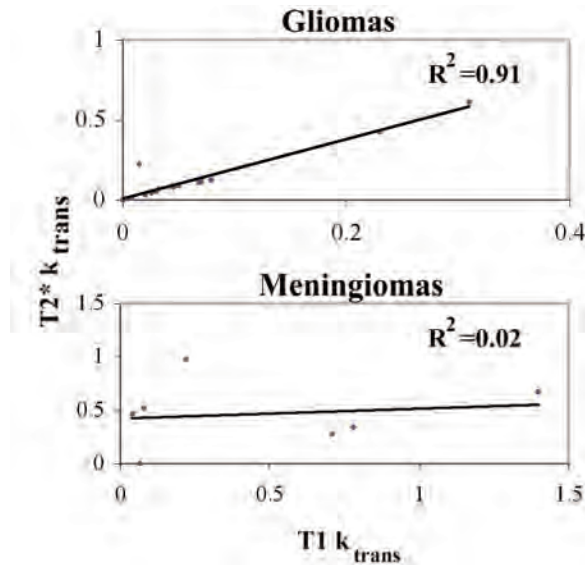
1H single voxel spectroscopy using PRESS sequence with TE = 135 ms was used, together with diffusion tensor imaging sequence ($b = 900 \text{ s/mm}^2$, matrix 128×128 , FOV = 210 mm, 19 slices, thickness 5 mm) in 7 low grade tumors, one case of gliomatosis cerebri and 8 high grade gliomas on 1.5 T scanner. External reference was used for absolute spectral quantification. Fractional anisotropy and mean diffusivity maps were calculated off-line.

RESULTS

Highest statistical significance in comparison of low to high grade gliomas was found measuring mean diffusivity (higher in low grade gliomas, $p < 0.005$ - two-tailed t-test). Next parameter was creatine content, which was found to be higher in low grade astrocytomas ($p < 0.015$). Fractional anisotropy was significantly higher in high grade astrocytomas ($p < 0.048$), whereas total choline content have not reached statistically significant difference between these two groups. In malignant gliomas: 1) mean diffusivity maps showed mixed pattern in necrotic core of the lesion, mean diffusivity was decreased at the viable tumor parts, 2) fractional anisotropy was decreased compared to normal white matter, 3) creatine levels were 3-4 times lower compared to normal tissue and choline was found to be increased slightly. Low grade gliomas are presented in general with: 1) decreased fractional anisotropy, 2) increased mean diffusivity, 3) mildly decreased creatine content. N-acetylaspartate was variably present in low grade astrocytomas and was absent in high grade astrocytomas. In the case of gliomatosis cerebri important finding is that fractional anisotropy significantly less decreased compared to low grade astrocytomas, whereas mean diffusivity was intermediately increased.

CONCLUSION

Main information given by spectroscopy is contained in ability to recognize degree of malignancy, while diffusion tensor imaging is useful to determine integrity of white matter tracts. Additionally, mean diffusivity correlates with cellularity of the tissue, and fractional anisotropy correlates with the higher level structures. In more malignant tumors, hypercellular tumors, fractional anisotropy expresses structural



CONCLUSION

The goals of our study were to measure and assess correlation between k_{trans} derived using steady-state T1 and dynamic susceptibility first-pass T2* methods in brain tumors. Our study suggests that k_{trans} derived by the steady-state T1 and the first-pass T2* methods are correlated linearly for gliomas but not for meningiomas. Although our sample size and range are limited, the good correlation we have found for gliomas suggests that the first pass T2* method may prove to be a valuable technique for estimating capillary permeability in gliomas as it may be more useful from a standpoint of image acquisition and computational speed. Further investigations to directly correlate imaging with histologic standards may strengthen the validity of T2* derived k_{trans} as a noninvasive imaging marker of microvascular permeability.

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KEY WORDS: Brain tumor, perfusion MR imaging, permeability

properties which are more connected to the tumor vascularity. In particular cases DTI was more successful in delineating gliomatosis cerebri from low grade glioma, and spectroscopy was superior in discriminating low grade tumors from those that are becoming more malignant.

KEY WORDS: Tumor, diffusion, spectroscopy

Paper 266 Starting at 10:55 AM, Ending at 11:03 AM

Multispectral Analysis of Physiologic MR Imaging for Tissue-Specific Clustering: Application to Gliomas Postradiation Therapy

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PURPOSE

Identification of early indicators for tumor recurrence are important in tumor patients postradiotherapy. Physiologic MR imaging methods including diffusion (to assess cellularity) and dynamic contrast-enhanced MR imaging (to assess blood volume and microvascular permeability) might help to identify recurrence. This study investigated whether these advanced MR methods could be used to differentiate tissue types in these patients, using a multispectral clustering approach in multidimensional “physiologic-space.”

MATERIALS & METHODS

Twelve patients with varying grades of glioma were imaged on a 1.5 T clinical MR system (GE Medical Systems, Signa Echospeed). Imaging included conventional anatomical as well as diffusion and dynamic contrast-enhanced MR imaging. For diffusion imaging a single-shot EPI sequence was used and parameters were as follows: (TR = 11250 ms, TE = 94 ms, FOV = 300 mm, slice thickness = 5 mm, no. of slices = 31, b = 0, 1000). For dynamic contrast-enhanced MR imaging a 3D GE sequence was used with the following parameters: (TR = 5.1, TE = 1.5, FOV = 220 mm, slice thickness = 10 mm, no. of slices = 10, NSA = 0.5). Temporal resolution per volume was 3.3 s and data acquisition continued for 36 dynamics. Gd-DTPA (Omniscan, Amersham Health) was administered after dynamic number 2. Apparent diffusion coefficient maps were calculated on a clinical workstation (GE Medical Systems) using Functool 2. Dynamic contrast-enhanced data were transferred to an independent workstation and evaluated using a 2-compartment model as previously described. Regions of interest were chosen on conventional images (mainly post-gad T1) by an experienced radiologist and mean and standard deviations of ADC, KPS, and fBV were recorded in tumor, edema, necrosis and normal white matter. Three-dimensional scatter plots with axes of ADC, fBV, and Kps were created to identify clusters of “physiologic similarity.” Clustered results were compared statistically using a one-way ANOVA.

RESULTS

A 2-dimensional plane summarizing results is shown in the figure. Apparent diffusion coefficient alone was able to resolve necrosis from other tissue with a cut-off value of 1800 $\mu\text{m}^2/\text{s}$. Apparent diffusion coefficient < 900 $\mu\text{m}^2/\text{s}$ resolved normal tissue from abnormal tissue. Specificity was 100%. fBV was able to resolve tumor from nontumor tissue with a cut-off value > 0.025. Specificity was 88%. K was not a good discriminator (63% specificity for tumor vs nontumor tissue).

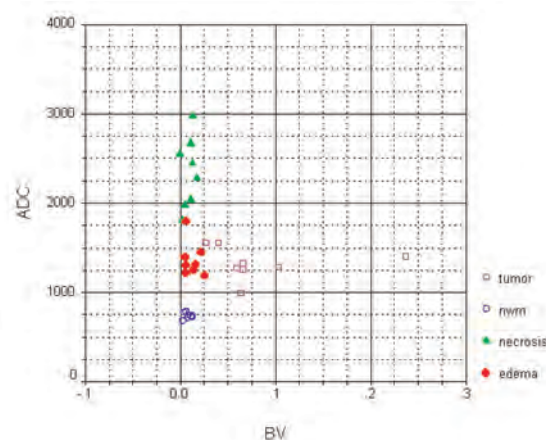


Figure: 2-dimensional view of multidimensional scatter plot, indicating tissue specific clustering.

Apparent diffusion coefficient > 1800 necrosis vs other tissue (specificity 100%); ADC > 900 nonnormal vs white matter (WM); ADC < 900 normal WM; BV > 0.025 tumor (specificity 88%); BV < 0.025 nontumor.

CONCLUSION

Our results show a single method is not able to separate all tissue types. However, clustering in multiparametric space allows separation with distinct cut-off values. Extensions of this methodology to include more physiologic (or spatial) dimensions promise the segregation of more tissue types (or more pathophysiologic specificity) as well as identifying redundant or obsolete imaging strategies.

KEY WORDS: Diffusion, permeability, multispectral

The authors of this work have indicated the following affiliations/disclosures: 1. General Electric Medical Systems: Research grant; 2. Toronto Image Processing Systems: Ownership.

Paper 267 Starting at 11:03 AM, Ending at 11:11 AM**Can Tumor Contrast Enhancement Be Used as a Criterion of Grading System of Oligodendrogliomas?**

White, M. L. • Zhang, Y. • Kirby, P. A. • Smoker, W. R. K.

University of Iowa College of Medicine
Iowa City, IA**PURPOSE**

Oligodendrogliomas are divided into low-grade (WHO II) and high-grade or anaplastic (WHO III) groups. The association of high-grade oligodendrogliomas with tumor contrast enhancement on MR imaging has been reported. Furthermore, some studies even use contrast enhancement as a criterion to differentiate two these grades: absence of endothelial hyperplasia and of contrast enhancement are low grade, and the presence of endothelial hyperplasia and/or of contrast enhancement are high grade. However, in our practice, MR imaging frequently shows both low-grade and high-grade oligodendrogliomas to be enhancing or nonenhancing. We therefore conducted retrospectively a review to correlate the tumor contrast enhancement with tumor histologic grade.

MATERIALS & METHODS

The study included 24 oligodendrogliomas in 23 consecutive patients (12 M and 11 F; age, 15-72 years) who had pretreatment MR imaging. All 24 tumors were confirmed pathologically by either resection (n = 19) or biopsy (n = 5). Sixteen oligodendrogliomas were low grade and 8 were anaplastic according to the WHO classification system. MR images were evaluated qualitatively regarding the presence/absence and the pattern of tumor contrast enhancement. The contrast enhancement ratios (CERs), the quantitative criteria, were calculated to evaluate the difference of the enhancement degree between the low-grade and the anaplastic tumors.

RESULTS

Contrast enhancement was noted in 9 of 16 (56%) low-grade tumors and in 5 of 8 (62.5%) anaplastic tumors. The CERs were 2.12 ~ 40.88 (mean, 20.08) in low-grade tumors and were 3.20 ~ 62.52 (mean, 28.73) in anaplastic tumors ($P > 0.05$). A characteristic enhancement pattern, nodular-like enhancement was found in 4 of 9 enhanced low-grade tumors and 4 of 5 enhanced anaplastic tumors. Histologic examination showed nodular-like areas to have the higher cell density and relatively increased neovascularity.

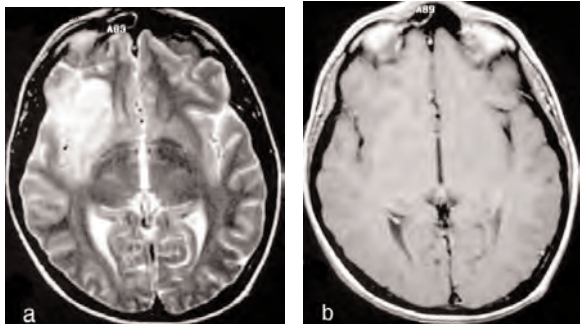


Figure. An anaplastic oligodendroglioma.

(a) T2-weighted image shows a high signal intensity mass that mainly involves the right frontal lobe and insula. (b) Contrast-enhanced T1-weighted image does not show obvious tumor contrast enhancement. The CER is 5.82.

CONCLUSION

We correlated the tumor contrast enhancement with histologic grade in oligodendrogliomas. Our results showed that the average CERs in the both tumor groups were not significantly different. We believe that the presence/absence of tumor contrast enhancement is not a specific finding for simply discriminating low-grade from anaplastic oligodendrogliomas. Histologic confirmation is necessary even in tumors without contrast enhancement.

KEY WORDS: Oligodendroglioma, histologic grade, MR imaging

Paper 268 Starting at 11:11 AM, Ending at 11:19 AM**Dynamic Susceptibility Contrast Perfusion MR Imaging of Low-Grade Gliomas: A Follow-Up Study of Lesions with Low vs High Relative Cerebral Blood Volume**

Law, M. • Wang, E. Y. • Oh, S. • Babb, J. • Zagzag, D. • Johnson, G.

New York University Medical Center
New York, NY**PURPOSE**

Low-grade gliomas can behave as true low-grade gliomas, may undergo malignant transformation, or in fact have underlying high-grade features not detected by initial histology because of inadequate sampling. The purpose of this study is to determine if initial and follow-up cerebral blood volume (CBV) and vascular permeability measurements (K^{trans}) can help predict tumor behavior in low-grade gliomas (LGGs).

MATERIALS & METHODS

Thirty-five patients with histologically diagnosed LGGs comprising of low-grade astrocytomas (n = 21), low-grade oligodendrogliomas (n = 13), and low-grade mixed oligoastrocytoma (n = 1) were studied with conventional MR imaging, and DSC MR imaging. Maximal rCBV measurements were obtained from regions of maximal perfusion abnormality as determined from rCBV color overlay maps. Vascular permeability measurements were derived simultaneously from a pharmacokinetic modeling algorithm. Patients then were divided into two groups (A and B) based on a threshold value of 1.75 (which was derived from previous logistic regression analysis of 120 high-grade gliomas and 40 low-grade gliomas at our institution to give the most optimal sensitivity and specificity for differentiating LGGs from HGGs). Perfusion parameters then were measured again at 6, 12, 18, and > 18 month follow-up studies.

RESULTS

Group A gliomas demonstrated rCBV and K^{trans} measurements of 1.20 ± 0.39 and 0.00014 ± 0.0002 (mean $\pm$ SD). The follow-up rCBV and K^{trans} measurements were 1.29 ± 0.48 and 0.00018 ± 0.0002 . P value for comparing the initial and follow-up rCBV and K^{trans} were 0.56 and 0.61 respectively. Group B gliomas demonstrated rCBV and K^{trans} measurements of 3.42 ± 1.45 and 0.0033 ± 0.013 (mean $\pm$ SD). The follow-up rCBV and K^{trans} measurements were 5.06 ± 2.96 and 0.0036 ± 0.011 . P value for comparing the initial and follow-up rCBV and K^{trans} were < 0.05 and 0.95, respectively.

CONCLUSION

The results suggest that DSC MR imaging can further differentiate LGGs into two groups, which appear to have different behavior on follow-up studies. LGGs with low initial perfusion tend to have low rCBV on follow-up whereas LGGs with high initial perfusion tend to have progressively increasing rCBV on follow-up. This indicates either a discordance between initial rCBV measurements and histologic assessment or that there is a subset of LGGs with increased rCBV, that may behave differently.

KEY WORDS: Low-grade gliomas, perfusion, cerebral blood volume

Paper 269 Starting at 11:19 AM, Ending at 11:27 AM

Corticospinal Tract Involvement Depicted by Diffusion Tensor Imaging before and after Brain Tumor Resection Correlates with Clinical Motor Findings

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University of Wisconsin
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PURPOSE

To assess the relationship between pre and postoperative diffusion tensor imaging (DTI) and clinical motor deficits in patients with space-occupying lesions involving the corticospinal tract (CST).

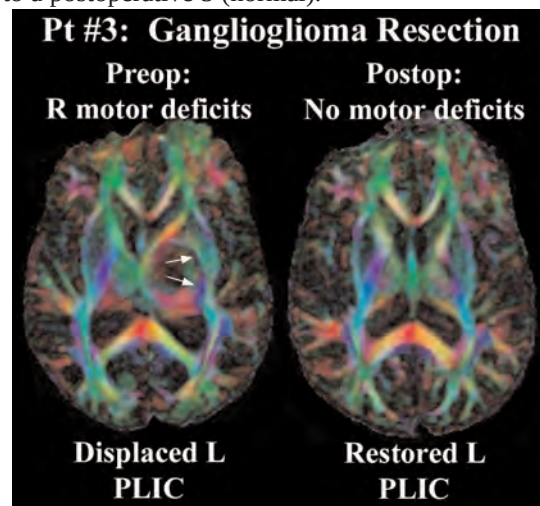
MATERIALS & METHODS

We retrospectively reviewed the pre and postoperative DTI patterns of 9 patients with masses potentially involving the CST (in close proximity to cerebral peduncle, posterior limb of internal capsule, or corona radiata). Masses also involving the motor cortex were discarded, leaving 4 patients (3 neoplasms, 1 cavernoma). Diffusion tensor imaging was performed at 1.5 T using a birdcage head coil, SS-EPI, TR/TE 4500/71.8 msec, NEX 4, FOV 240 mm, slice 3 mm, voxel size interpolated to 0.94 mm isotropic, and diffusion encoding in 23 directions with $b = 0, 1000 \text{ sec/mm}^2$. Postprocessing included image registration, 3×3 in-plane spatial median filter, tensor decoding and diagonalization (1). A neuroradiologist, blinded to the results of physical examination, determined CST involvement from color-coded maps of major eigenvector direction, on which color brightness was modulated by fractional anisotropy. The CST was considered to be involved if it was either displaced (abnormal position) or edematous/infiltrated (decreased anisotropy) (2). CST appearance pre and postoperatively was compared with contralateral motor strength using the Medical Research Council's 0-5 rating.

RESULTS

Of the 4 patients with potential CST involvement preoperatively, DTI confirmed CST involvement in 3 patients, all of whom had preoperative motor deficits. The patient without CST involvement on DTI had no motor deficit. Postoperatively, DTI showed CST preservation and normalization of position and/or anisotropy in 2 of the 3 patients with preoperative deficits, and both of those patients showed improvement in their motor strength. The other patient with preoperative deficits had evidence of Wallerian degeneration

with CST atrophy on DTI and showed only equivocal improvement in motor strength. The figure shows an example of a laterally displaced posterior limb of internal capsule with normalization of tract position after tumor resection. This patient's motor strength increased from a preoperative 3.5 to a postoperative 5 (normal).



CONCLUSION

In this small cohort of patients with masses potentially involving the CST, the appearance of the CST on pre and postoperative DTI correlated well with the clinical motor examination. Further study is warranted to define the role of DTI in planning tumor resections and predicting postoperative motor function.

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KEY WORDS: Diffusion tensor imaging, brain tumors, surgical planning

The authors of this work have indicated the following affiliations/disclosures: National Institutes of Health: Grant #R01 EB002012.

Paper 270 Starting at 11:27 AM, Ending at 11:35 AM

Comparison of Tumor Perfusion Measured by Spin Labeling Method and Gadolinium-Injected Dynamic Perfusion Study Using MR Imaging

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PURPOSE

In our previous reports, it was shown that the image contrast on the flow-sensitive alternating inversion recovery (FAIR) technique in ischemic cerebral disease was well correlated with that of the paramater maps by postcontrast dynamic perfusion MR imaging (1). However, it is known that the

hemodynamic change on the brain tumor is variable and influential under the change of vascular permeability and the existence of angiogenesis and necrosis. In this study, we applied the FAIR technique and the various parameter maps by postcontrast dynamic perfusion MR imaging on the same patients with brain tumor for the comparison of the perfusion contrast. The further analysis for postcontrast dynamic perfusion data was conducted using independent component analysis (ICA).

MATERIALS & METHODS

The subjects were 15 patients with the primary brain tumor (4 cases: glioblastoma, 4 cases: low grade glioma, 4 cases: malignant lymphoma, 2 cases: meningioma, 1 case: gliomatosis cerebri). The instrument of MR imaging was a clinical 1.5 T apparatus (Signa Horizon, GE, Milwaukee, WI) with a standard headcoil. The sequences of FAIR technique and postcontrast dynamic method were prepared based on the gradient-echo type EPI, and the measurement conditions of each technique were $TI = 1600$ ms, $TR = 20000$ ms, $TE = 20$ ms, Matrix = 128×128 (FAIR), and $TR = 2000$ ms, $TE = 55$ ms, Matrix = 128×128 , 55 phases (dynamic), respectively. The parameter maps of MTT, rCBF, rCBV and static CBV were generated by the deconvolution analysis using MEDx Ver 3.42 (Sensor system, USA) and time series data was evaluated by ICA. The image contrast was evaluated by visual estimation of two radiologists, and semi-quantitative comparison by signal intensity ratio (tumor/opposite normal tissue) also was conducted.

RESULTS

The high flow tumor such as meningioma and the low vascular tumor such as most of the glioblastoma showed the same tendency of image contrast between FAIR technique and rCBF map. However, three cases of malignant lymphoma showed discrepancy of image contrast between two methods. The signal ratios (tumor/opposite normal tissue) between FAIR technique and each parameter map showed in Table 1, and it was found that the correlation between FAIR and MTT was relatively low ($r = -0.19$) as opposed to our result of the ischemic disease. The correlation between FAIR and rCBF was not as good as the result of the ischemic disease. Independent component analysis showed different time curve shape of signal changes in the tumor that might cause miscalculation of perfusion parameter.

Correlation Coefficients between FAIR and Parameter Maps

	FAIR	CBF	CBV	MTT
FAIR	1.00	0.49	0.66	-0.19
CBF	0.49	1.00	0.88	-0.43
CBV	0.66	0.88	1.00	-0.38
MTT	-0.19	-0.43	-0.38	1.00

CONCLUSION

The perfusion contrast in tumor cases may be different depending on various perfusion MR technique and the miscalculation might be occurred to generate parameters from the time series data by contrast dynamic study.

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KEY WORDS: Perfusion, brain tumor, MR imaging

Paper 271 Starting at 11:35 AM, Ending at 11:43 AM

Microvascularity within Human Gliomas Identified at 8 T High Resolution MR Imaging and Histopathology

Christoforidis, G. A. • Yang, M. • Figueredo, T. • Chakeres, D. W. • Abduljalil, A. • Chaudhury, A. • McGregor, J. • John, C. • Newton, H.

The Ohio State University
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PURPOSE

To determine whether microvascularity identified within gliomas using ultrahigh resolution MR gradient-echo imaging at 8 T correlates with tumor grade.

MATERIALS & METHODS

Gradient-echo images were acquired from 24 patients with gliomas using a TEM resonator operating in quadrature and tuned to 340 MHz (8 T). A prototype whole body 8 T imaging system was used. All patients signed consents and the exams were done under an IRB approved protocol. Typical acquisition parameters were as follows: matrix = 1024×1024 , flip angle = $20-45^\circ$, $TR = 750$ msec, $TE = 17$ ms, FOV = 20 cm, slice thickness = 2 mm. This resulted in an in-plane resolution of about 200 microns. Images were analyzed and areas of altered signal intensity and disturbed microvasculature were identified within the brain tumors. The number of foci with areas of abnormal vasculature, as well as the size and density of the abnormal microvascular structures relative to gray matter and white matter were determined semiquantitatively. These then were compared to tumor grades according to the WHO classification of primary brain tumors. Tumor extent also was compared to that identified on 1.5 T MR images.

RESULTS

The 8 T images demonstrated high signal regions similar in distribution to the 1.5 T images outlining the margins of the masses in all patients. None of the intraparenchymal vessels were visible at 1.5 T. Many small intraparenchymal vessels, hundreds, primarily veins deep within the brain were visualized at 8 T. These vessels typically were detected as linear signal voids. There was distortion of the vasculature including displacement, enlargement, increased number, and abnormal tortuosity. Distorted vessels within the tumor bed were suspicious for neovascularity. Contingency table analysis indicated that there was a statistically significant correlation between number of foci of microvascularity within the tumor bed ($p < 0.0011$) and size of abnormal vessels within the tumor bed relative to normal brain ($p < 0.01$).

CONCLUSION

High resolution 8 T imaging provides a unique detailed view of distorted cerebral microvasculature in brain tumors in vivo on cross-sectional imaging. This vascular prevalence may show promise as a marker for tumoral microvascularity. Furthermore, high resolution 8 T MR imaging potentially could allow differentiation of high from low grade astrocytomas.

KEY WORDS: Glioma, microvascularity, high field MR imaging

Thursday Morning

10:15 AM - 11:45 AM

Room 611 - 612

(54d) Spine: General, Spinal Cord (Scientific Papers 272 - 284)

See also Parallel Sessions

(54a) Spine: Degenerative Disk Disease and Biomechanics

(54b) Interventional: New Devices

(54c) Adult Brain: Neoplasms

Moderators: Wendy A. Cohen, MD
M. Judith Donovan Post, MD

Paper 272 Starting at 10:15 AM, Ending at 10:23 AM

Cross-Sectional Gray/White Matter Differentiation of the Human Spinal Cord In Vivo at 3 T Using a Dedicated Spinal Coil

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PURPOSE

The spinal cord is a highly structured tissue consisting of gray matter (GM) containing primarily cell bodies and assuming a butterfly-shaped central position in cross-section, and white matter (WM) containing densely packed, rostro-caudally oriented axons in the periphery. Despite the sensitivity of T2-weighted MR imaging for evaluating tissue damage associated with spinal cord pathology, the gross anatomical differentiation between gray and white matter has not been possible on routine scans due to limitations in SNR and spatial resolution. In this study, we demonstrate the feasibility of obtaining high-quality MR images of the human spinal cord in vivo, in clinically acceptable scan times at a 3 T MR system, using an imaging protocol optimized for contrast between gray and white matter and cerebrospinal fluid (CSF).

MATERIALS & METHODS

Experiments were performed at a 3 T MR system (80 mT/m, 100 mT/m/ms gradient coils), using a 12-element, phased-array, dedicated spine coil. Five healthy adult volunteers were scanned in 15 5mm thick axial sections (0.5 mm gap, in-plane resolution = 0.59 x 0.73 mm) in three acquisitions: C2-C6 (cervical), Th1-Th5 (thoracic), and Th9-L1 (lumbar) vertebral segments. A target imaging time of 6 min was enforced, with the number of signal averages (NSA) being maximized under this constraint. Flow-compensation gradi-

ents and anterior spatial saturation bands were applied to suppress motion artifacts from breathing, swallowing, and CSF flow. A 2D FFE T2-weighted sequence was optimized for image contrast and SNR at the cervical segment of the volunteers by varying systematically the TR (260-2000 ms), the TE (8.2-10.3 ms) and the flip angle (FA) (10°-50°). The optimization process consisted of visual inspection and signal intensity measurements of GM, WM, CSF, and standard deviation of the background noise.

RESULTS

Our measurements showed that the level of CNR is quite robust across a large range of TRs. For a given TR there is also a range of near optimal FAs, provided adequate SNR is achieved. There is a small improvement achieved by acquiring signal during the in-phase condition for water and fat (TE: 9.2 ms). Excellent tissue contrast and visualization of the internal anatomy of the spinal cord was achieved with the following parameters: TR/TE/FA/NSA = 523 ms/9 ms/30°/3 for an acquisition time of 4 min 50 sec. With this protocol, high quality images of the cervical and lumbar regions allowing differentiation of the ventral and dorsal horns and the commissure of the gray matter, the ventral median sulcus, and the ventral, lateral, and dorsal funiculi of the white matter were obtained in all subjects. Images of the thoracic spine allowed gray/white matter differentiation, but were more prone to motion related signal artifacts.

CONCLUSION

Delineation of the gross cross-sectional anatomy of the human spinal cord in vivo can be achieved in clinically acceptable scanning time using an optimized 2D FFE, T2-weighted sequence on a 3 T MR system with a dedicated spine coil. This progress in resolution and tissue differentiation is expected to lead to improved evaluation of the location and extent of tissue damage associated with disorders of the spinal cord. Preliminary applications to patients with multiple sclerosis corroborate this expectation.

KEY WORDS: Spinal cord, anatomy, high resolution MR imaging

Paper 273 Starting at 10:23 AM, Ending at 10:31 AM

Quantitation of the Intramyelinic Water Compartment in Demyelinating Lesions of the Cervical Spinal Cord: Feasibility and Comparison with Magnetization Transfer and Diffusion Tensor Imaging

Field, A. S. • Wu, Y. • Alexander, A. L. • Fleming, J. O. • Duncan, I. D.

University of Wisconsin
Madison, WI

PURPOSE

To test the feasibility of myelin water quantitation in the cervical cord and compare these measurements in multiple sclerosis (MS) to other myelin-related parameters, specifically, magnetization transfer ratio (MTR) and fractional anisotropy (FA) of water diffusion.

MATERIALS & METHODS

Six healthy volunteers and four MS patients with visible cord lesions underwent an inversion-prepared, multiple spin-echo pulse sequence that obtained 32 echoes from a single slice at increasing TEs (1.5 T GE Signa, body coil transmit, single-element cervical spine coil receive, TI 1500 ms, TR 3000 ms, echo spacing 7.2 ms, slice thickness 4 mm [sagittal] or 5 mm [axial], matrix 128 x 128, FOV 18 cm, NEX 2). Three of the volunteers were scanned twice, on separate days, for reproducibility testing. T2 distributions were calculated for each voxel by nonnegative least-squares fitting of the decay curves (1). Myelin water fraction (MWF) was defined as the ratio $S_s/(S_s+S_m)$, where S_s and S_m are the signal amplitudes with short (10-50 ms) and medium (50-150 ms) T2 times, respectively. An interleaved 3D MT sequence (2) was used to minimize motion effects in obtaining MTR data. An FSE-based sequence (PROPELLER) (3) with 6 diffusion encoding directions was used to obtain diffusion tensor data, from which FA was calculated. Regions of interest limited to cord parenchyma were obtained with a semi-automatic segmentation procedure using iterative thresholding to minimize partial volume effects.

RESULTS

Myelin water fractions in MS lesions were (mean $\pm$ SD) 20% $\pm$ 3% compared to 25% $\pm$ 2% in controls ($p < 0.05$, two-sample t-test). Day-to-day coefficients of variation ranged from 3-10%. There were no significant differences between sagittal- and axial-plane MWF measurements. Myelin water fraction and MTR were correlated over all subjects ($R = 0.64$) but not within groups (although within-group variance was limited). Myelin water fraction and FA were highly correlated over all subjects ($R = 0.88$) and remained correlated within groups ($R = 0.98$ in MS lesions).

CONCLUSION

These preliminary results suggest that quantitation of the intramyelinic water compartment in cervical spinal cord is feasible, reproducible, and sensitive to pathology in MS lesions. The MWF shows expected correlations with other myelin-sensitive parameters but further study with more pathologically heterogeneous subjects is needed to elucidate the extent to which MWF provides redundant or complementary information.

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KEY WORDS: Myelin water, diffusion tensor, magnetization transfer

The authors of this work have indicated the following affiliations/disclosures: General Electric Medical Systems: Use of proprietary, noncommercial software under research agreement.

Paper 274 Starting at 10:31 AM, Ending at 10:39 AM

Spinal Cord Atrophy Occurs Early in the Natural History of Diabetic Neuropathy

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PURPOSE

Diabetes is among the most common diseases to affect the nervous system. Distal symmetrical polyneuropathy (DSP) is its most frequent consequence, affecting 40% of diabetic patients. Once considered a disease of the peripheral nervous system, manifestations of DSP within the central nervous system are being increasingly recognized. Spinal cord atrophy has been reported previously by our unit, in established DSP but the relevance of this to its pathogenesis depends if spinal cord involvement occurs early in the natural history (1).

MATERIALS & METHODS

To date, 77 type 1 male diabetic patients and 15 healthy volunteers (HV) have been studied. Following a detailed neurologic evaluation, diabetic patients were divided into three groups. Group 1, 27 had no DSP (No-DSP), group 2, 20 had subclinical or early DSP (Sub-DSP) and group 3, 30 had established DSP (Est-DSP). All patients and HV underwent MR imaging of their cervical spine using a standard spinal phased-array receive-only RF coil on a system operating at 1.5 T (Eclipse, Philips Medical Systems). T2*-weighted imaging was performed axially from C1-T2 using a gradient-echo technique (TE = 17.9 ms, TR = 800 ms; $\alpha = 40^\circ$; slice thickness = 4 mm; in-plane resolution = 0.78 mm x 0.96 mm). Images were postprocessed on a Sun Workstation and cross-sectional cord area was calculated, at disk space C2/C3, using the image display program Dispimage (2). Calculated CSA then were corrected for errors in slice positioning and as this is a cross-sectional study, corrections for shrinkage over time were also made. Inter and intraobserver variations were determined.

RESULTS

Group means were compared first using one-way Anova ($p < 0.0001$) and then independently with t-tests. Mean cord CSA was significantly lower in both Est-DSP and Sub-DSP compared to either HV or No-DSP ($p < 0.0001$). There were no significant differences in cord CSA between the two DSP groups (Sub-DSP vs Est-DSP, $p = 0.81$) or between Sub-DSP and HV ($p = 0.71$). In addition 15% of Sub-DSP and a comparable 16% of Est-DSP had spinal cord atrophy (2SD below mean CSA of HV). Further morphometric analysis showed an early reduction in the mediolateral cord diameter before reduction in the anteroposterior diameter ($p = 0.025$).

CONCLUSION

This study shows that spinal cord involvement occurs early in the natural history of DSP, suggesting concomitant spinal cord and peripheral nerve involvement. Furthermore the cord shape changes quantified as an early reduction in the mediolateral cord diameter suggests preferential involvement of the spinothalamic tracts in DSP. Finally this rapid, noninvasive test may serve as an early marker for DSP.

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KEY WORDS: Distal symmetrical polyneuropathy, diabetes mellitus, spinal cord

Paper 275 Starting at 10:39 AM, Ending at 10:44 AM

Glioblastoma Multiforme of the Conus Medullaris in a Child: Description of a Case and Literature Review

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²University of California San Diego Medical Center, San Diego, CA

PURPOSE

Intramedullary neoplasms are rare (5%) (1). In children, the quotient of intramedullary tumors is higher, rising up to 35% of all spinal neoplasms(2), and mostly low-grade gliomas (89%). We describe the MR and pathologic features in a case of glioblastoma multiforme of the conus medullaris, that occurred in a child.

MATERIALS & METHODS

C.O., male 14 years old, came to our attention for slowly progressive motor weakness of the legs, exacerbated 15 days before after a minor accidental trauma. He showed an important paraparesis, abnormal gait, right foot flexion failure, right scyatalgia, urinary function alteration, perineal hypo-aesthesia. Achillea reflexes were absent. Brain and spine MR scans were performed, and then a surgical bioptical and excisional procedure. Patient came back at follow-up examination after 12 months.

RESULTS

MR scan showed at T12 level, an intramedullary signal alteration extending to the L1 level. The finding, sized 3.5 x 2 cm, with ovoid morphology, showed homogeneous hyperintense signal in T2-weighted images, hypointense signal in T1-weighted images, was well demarcated, with a circumferential cord expansion. After gadolinium, there was a slight and faint enhancement localized in two nodules in the upper cranial portion of the conus, better shown in the coronal plane. The finding was consistent with a spinal cord low-grade astrocytoma. The patient has been treated surgically with ablation of the mass, resulting in a postoperative course with a moderate progressive improvement of leg strength, but also with a neurologic impairment of bladder function. Eight months after the surgical treatment, the patient showed a local recurrence with leptomeningeal endocanal spread all along the spinal canal and the posterior fossa. Pathologic Findings: On H&E, the tumor was composed of moderately pleomorphic cells, with iperchromatic nuclei and prominent nucleoli, that focally stained by anti-GFAP antibody. Occasionally, mucoid degeneration, microcysts, and

microvascular proliferation were found. No necrotic areas were identified. Mitotic index was low (2 x 10HPF), but growth fraction, as determined by anti-Ki67 antibody indicate high proliferative tumor-cell activity (25%). p53 was highly expressed (65%). The final pathologic response was consistent with a glial intramedullary neoplasm compatible with glioblastoma multiforme (GBM).

CONCLUSION

Astrocytomas are the more frequent intramedullary neoplasm in children. The single isolated conus medullaris involvement is reported in few cases in the literature (3). In two large pediatric intramedullary neoplasm case series, high-grade astrocytoma (III and IV) accounted for 5% and 11% of the cases. In rare cases, there can be a metastatic localization in the conus from a brain primitive GBM localization elsewhere. Spinal astrocytomas in the pediatric age must be differentiated from gangliogliomas, ependymomas, and epydermoid/dermoid tumors. This case appears unusual both for the hysto-type and the non-specific MR features.

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KEY WORDS: Intramedullary, neoplasm, glioblastoma

Paper 276 Starting at 10:44 AM, Ending at 10:52 AM

Clinical and MR Imaging Features of Cavernous Malformations of the Spinal Cord

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PURPOSE

Spinal cord cavernous malformations (SCCMs) are by far less common and less known than brain cavernous malformations, but may induce severe neurologic deficits, eventually requiring surgical treatment. The purpose of this presentation is to describe clinical and MR imaging features of SCCMs, in order to define incidence of clinically significant hemorrhages, and report MR imaging diagnosis, as well as on neurologic outcome, and follow-up after surgery.

MATERIALS & METHODS

Clinical and MR imaging data of 15 patients (9 males and 6 females, age range 10-61 years) with a definite diagnosis of 16 SCCMs are reported. Ten patients have been examined at 1.5 T, 1 at 1 T, and 4 at 0.5 T units. GRE T2*-weighted images were obtained in all the patients, and postgadolinium-enhanced T1-weighted images in 13. Selective digital subtraction angiography was performed in 3 patients. Twelve patients have been operated: follow-up duration range is 2-15 years.

RESULTS

Typical strong hypointensity on GRE T2*-weighted images was found in all the 16 SCCMs. A central hyper-intense core was seen on T2-weighted images in 9 patients and on T1-weighted images in 7 patients. Faint to moderate contrast-enhancement occurred in 4 SCCMs. Adjacent dilated enhancing veins were shown in 3 patients. Macroscopic “extra-capsular” hemorrhage was found in 4 SCCMs at symptoms onset, and occurred during follow-up in 2 SCCMs. In 11 out of the 12 operated patients, SCCMs were completely microscurgically removed. Six months after surgery, 7 patients did not changed in their neurologic status, four improved, and one worsened. In 9 out of the 11 completely removed SCCMs, there was a persistent strong hypointensity on GRE T2*-weighted images, due to residual hemosiderosis of adjacent spinal cord.

CONCLUSION

MR features of SCCMs are exactly the same as brain cavernous malformations. Macroscopic hemorrhages seem to occur more frequently. Postsurgical outcome is better than in other intramedullary spinal cord tumors, thus aggressive surgical approach is to be considered justified.

KEY WORDS: Spinal cord cavernous malformations, MR imaging, follow-up

Paper 277 Starting at 10:52 AM, Ending at 11:00 AM

Effect of Relative Obstruction at the Foramen Magnum on Cerebral Spinal Fluid Velocities and Pressures through the Cardiac Cycle: Studies in an Experimental Model

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Madison, WI

PURPOSE

The purpose of the study is to test the hypothesis that elevations in cerebral spinal fluid (CSF) velocity in the foramen magnum during the cardiac cycle predict increased CSF pressure fluctuations at the foramen magnum.

MATERIALS & METHODS

MR images transversely through the foramen magnum are acquired with phase contrast velocity encoding techniques in mongrel dogs under ketamine anesthesia. Cerebral spinal fluid flow is calculated from the dogs as in human studies. For the CSF pressure measurements, the dog is placed on the fluoroscopic table in the animal laboratory. The lumbar subarachnoid space is cannulated and a Radi 0.014 “ guide wire mounted pressure sensor (17 mm length) is passed through the cannula and into the subarachnoid space and into the inferior posterior fossa. Cerebral spinal fluid pressures are recorded with an Accuphase monitor. The catheter is withdrawn to the upper cervical spinal canal and pressure measurements repeated. To simulate obstruction, a balloon catheter (Commodore 3.5 x 10 mm, 0.015 ID) is inserted percutaneously through the cannula and manipulated under fluoroscopic monitoring to the foramen magnum (Figure 1). After placement of the balloon catheter, pressures are measured above and below the balloon catheter before and after

inflation of the balloon. The wire is removed and the animal transported to the MR suite, where PC MR imaging is repeated.

RESULTS

PC MR flow studies in the dog show two nodes with increased velocities in the anterior subarachnoid space, as in humans (Figure 2). With the inflation of the balloon in the foramen magnum, CSF velocities and CSF pressure fluctuations increase.

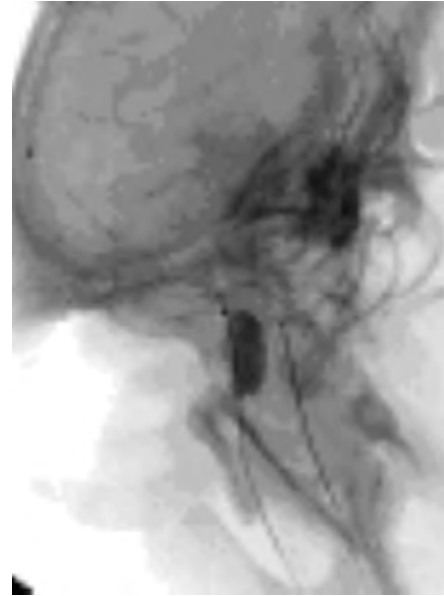


Figure 1.* Fluoroscopic image shows position of the Radi wire in the subarachnoid space and of the balloon catheter at C2 in the foramen magnum. The balloon is inflated with contrast medium.

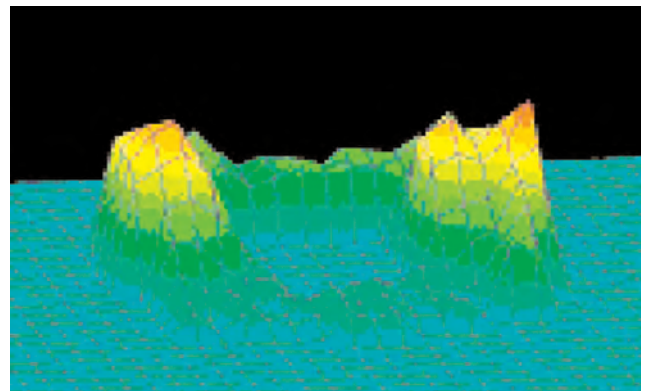


Figure 2. Surface contour display of the CSF velocity data in an axial image at the foramen magnum in a dog. Higher velocities are evident in the anterior subarachnoid space (further from viewer) and reduced flow in the posterior subarachnoid space (closer to viewer). Velocities are greatest anterolateral to the cord, as in normal human subjects.

CONCLUSION

Changes in CSF velocity increases in the foramen magnum during the cardiac cycle correlate with changes in CSF pressure fluctuations. The increase in pressure correlates positively with an increase in peak systolic and peak diastolic velocity.

KEY WORDS: Chiari I malformation, syringomyelia, CSF flow

Paper 278 Starting at 11:00 AM, Ending at 11:08 AM**Motion of the Spinal Cord during the Cardiac Cycle in Adult Patients with a Chiari I Malformation and Adult Volunteers**Quigley, M.¹ • Haughton, V. M.¹ • Nicosia, M.² • Iskandar, B.¹¹University of Wisconsin Hospitals and Clinics, Madison, WI, ²University of Minnesota, Minneapolis, MN**PURPOSE**

Spinal cord and tonsils have been reported to move at greater velocities in patients with a Chiari I malformation than in normal subjects. Whether spinal cord movement is primary or secondary to CSF flow is not known. Therefore, we measured cord velocities and compared them to CSF velocities in normal subjects, patients with a Chiari I malformation, and patients who underwent cranio-occipital decompression for a Chiari I malformation.

MATERIALS & METHODS

We acquired cardiac gated PC MR imaging in axial plane at the foramen magnum in groups of Chiari I patients prior to cranio-occipital decompression, in the same group after decompression, and in 10 normal volunteers. Cerebral spinal fluid velocity averaged over the foramen magnum was calculated by conventional methods at 14 points during the cardiac cycle. Movement of the spinal cord was calculated by measuring the velocity of voxels superimposed on the spinal cord at the same 14 time points. The CSF and spinal cord velocities in the same subject were compared. Averages for CSF velocity and spinal cord velocity at each point in the cardiac cycle were computed for the normal subjects and patients pre and postoperatively.

RESULTS

Spinal cord velocities are small compared to CSF velocities in all three groups. Little difference is noted in the three groups. All three groups show a small low velocity caudad displacement at the 3rd time point in the cardiac cycle and a low velocity displacement of the cord in a cephalad direction at the 12th point. These displacements coincide with the maximal acceleration of CSF flow in the same direction.

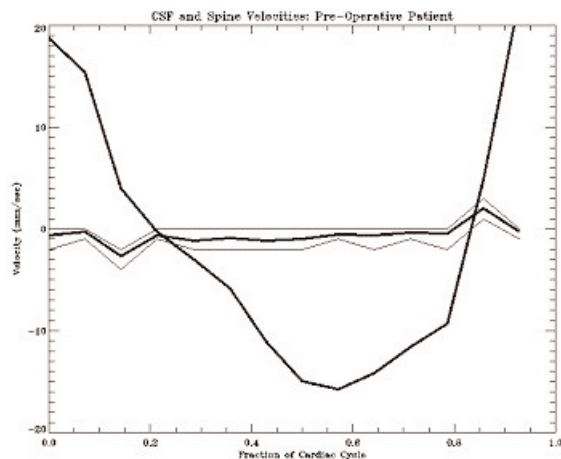


Figure 1: CSF (black line) and spinal cord velocities (black line with error calculation) over the cardiac cycle at the foramen magnum in a patient with a Chiari I malformation. Note that CSF velocities exceed the cord velocities. Maximal cord velocities coincide with the maximal change in velocity of the CSF at the 3rd and 12th time point in the cardiac cycle.

CONCLUSION

Spinal cord velocities are not increased significantly in patients with a Chiari I malformation. The motion of the spinal cord may be secondary to the acceleration of CSF flow.

KEY WORDS: Chiari I malformation, CSF flow, MR imaging

Paper 279 Starting at 11:08 AM, Ending at 11:16 AM**Spiraling Crescent Sign of Cervicocephalic Arterial Dissection**

Liebeskind, D. S. • Cross, B. J. • Weigle, J. B. • Hurst, R. W.

University of Pennsylvania
Philadelphia, PA**PURPOSE**

Cervicocephalic arterial dissection results from trauma or an inherent structural defect in the vessel wall. Although microscopic examination may reveal disruption of normal vessel wall architecture caused by intramural hematoma, gross pathologic evaluation yields minimal insight on the specific pathophysiologic events associated with dissection. We characterized the morphology of cervicocephalic arterial dissection and investigated the spiraling configuration of the intramural hematoma on MR imaging acquired at initial diagnosis.

MATERIALS & METHODS

Retrospective review of axial fat-saturated T1-weighted MR imaging acquired at the time of initial diagnosis of cervicocephalic arterial dissection was conducted in 43 cases (median age 47 years, range 20-70 years; 25:18 M:F). Detailed morphologic analysis of 49 dissections included measurement of dissection length, degree of luminal stenosis, shape of the intramural hematoma, presence of spiraling, and rate of spiraling along the vertical axis.

RESULTS

Morphologic analyses included 28 left internal carotid, 21 right carotid, 13 left vertebral, and 8 right vertebral artery dissections. Dissection length averaged 18.9 mm (range 5-48 mm). Intramural hematoma resulted in elongated luminal stenoses (mean 35.4%, SD $\pm$ 10.4%), with vessel occlusion in 3/49 (6%) dissections. A crescentic intramural hematoma was observed in 38/49 (78%). Spiraling of the intramural hematoma and corresponding vessel lumen was noted in 34/46 (74%) of dissections that were observed on more than one axial slice. An overall clockwise orientation was readily apparent in 18/34 (53%) spiraling dissections, with a counter-clockwise orientation in 16/34 (47%). The overall orientation of spiraling was not dependent on vessel type or laterality. Detailed measurement revealed that the dissections spiraled an average of 9.14 degrees per mm of dissection length. Spiraling was less apparent in short or segmental dissections and lesions situated at the transverse portion of the vertebral artery. The orientation of spiraling noted on detailed measurement changed direction in 23/34 of spiraling dissections, typically occurring only after the proximal segment of the dissection.

CONCLUSION

A spiraling, crescentic intramural hematoma or a helical flow void may be characteristic findings of cervicocephalic arterial dissection. The spiraling crescent sign of dissection may have clinical applications in the diagnosis of dissection or identification of dissecting aneurysms. Spiraling may be inapparent in short, segmental dissections or isolated vertebral dissections. The pattern of spiraling in cervicocephalic arterial dissections suggests that the spiral configuration may result from a combination of hemodynamic forces that are maximal at the proximal end of the dissection interacting with influences of vessel wall architecture that increase along a longitudinal gradient.

KEY WORDS: Dissection, vascular, stroke

Paper 280 Starting at 11:16 AM, Ending at 11:21 AM

Dynamic Angiography in the Diagnosis of Rotational Vertebral Artery Occlusion

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PURPOSE

Rotational vertebral artery occlusion is a condition where blood flow through the vertebral artery is compromised during head movement. It also is known as “Bow Hunter’s stroke.” We describe the use of dynamic angiography in the evaluation of a rare case of bilateral rotational vertebral artery occlusion.

MATERIALS & METHODS

A 17-year-old female presented to the neurosurgery outpatient clinic with a history of headaches and syncope. Past medical history was remarkable for frequent joint dislocation, T1/T2 degenerative disk disease, asthma, and family history of connective tissue disease. Following a genetic consultation, patient was diagnosed with Nail-Patella syndrome, a rare genetic disorder affecting bone and connective tissue with variable symptomatology. Dynamic angiography established rotational vertebral artery occlusion. A C1-C2 fusion was performed to limit rotation and arterial compression.

RESULTS

MR angiography demonstrated no cerebral vascular abnormalities except for tortuosity of the distal left vertebral artery. Conventional angiography demonstrated no evidence of occlusion or stenosis in the anterior cerebral circulation; there was no evidence of vertebral artery occlusion and there was an intact posterior communicating artery. However, when the patient was asked to turn her head to the right, left vertebral angiography demonstrated complete occlusion of the left vertebral artery; flow was progressively restored as the patient shifted her head towards midline with complete restoration of vertebral artery flow with the head at midline. Similarly, right vertebral angiography demonstrated complete occlusion of the right vertebral artery when the patient’s head turned to the left; flow was progressively restored as the patient shifted her head towards midline with complete restoration of right vertebral artery flow with the

head at midline. There was no change in right vertebral artery flow when the head was turned to the right. Pinching of the vertebral arteries was observed at C2 where the vertebral arteries course anteriorly.

CONCLUSION

Rotational vertebral artery occlusion is a rare cause of transient vertebrobasilar insufficiency and syncope. This case demonstrates the effectiveness of dynamic angiography in establishing this diagnosis.

KEY WORDS: Rotational vertebral artery occlusion, Bow Hunter’s stroke, dynamic angiography

Paper 281 Starting at 11:21 AM, Ending at 11:26 AM

Lymphoma of a Lumbar Nerve Root: Confirmation with ¹⁸Fluorodeoxyglucose Positron Emission Tomography

Chao, C. P. • Kotsenas, A. L. • Weindling, S. M. • Broderick, D. F.

Mayo Clinic
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PURPOSE

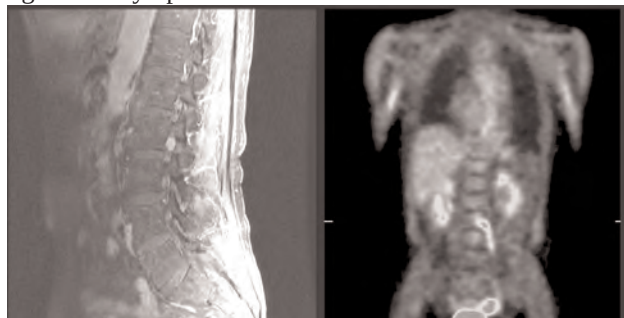
Lymphoma uncommonly involves extradural nerve roots and can be difficult to distinguish from benign nerve sheath tumors on MR imaging (1). This case illustrates the utility of ¹⁸fluorodeoxyglucose positron emission tomography (¹⁸FDG-PET) imaging in the discrimination of malignant and benign nerve root lesions through an unusual case of a large B-cell lymphoma involving the second lumbar (L2) nerve root.

MATERIALS & METHODS

A 69-year-old male presented with progressive left hip, thigh, and knee pain, left leg weakness, and a 30-pound weight loss over 4 months. MR imaging of the lumbar spine was performed without and with gadolinium followed by whole body ¹⁸FDG-PET.

RESULTS

MR imaging of the spine revealed contrast enhancement and enlargement of the intrathecal and extradural intraforaminal portion of the left L2 nerve root with widening of the foramen. The intrathecal involvement resembled leptomeningeal carcinomatosis; however, the intraforaminal nerve root involvement raised the possibility of a concurrent benign nerve sheath tumor. A PET scan demonstrated abnormal hypermetabolic activity within the lumbar thecal sac and extending into the left L2 neural foramen corresponding to the enhancement on MR imaging. Malignancy was confirmed by cerebral spinal fluid cytology consistent with a large B cell lymphoma.



CONCLUSION

Several reports have described the utility of PET in differentiating malignant from benign schwannomas (2, 3). Lymphomatous involvement of the central nervous system sometimes exhibits similar MR findings as benign tumors such as schwannomas and neurofibromas. In this case, ¹⁸FDG-PET imaging noninvasively established the spinal nerve root lesion as a malignancy distinct from other benign tumors.

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KEY WORDS: Lymphoma, FDG-PET, nerve root

Paper 282 Starting at 11:26 AM, Ending at 11:31 AM

Sporadic Extradural Spinal Hemangioblastoma: Report of Two Cases

Zimmerman, D. L. • Lefton, D. R. • Pinto, R. S.

Beth Israel Medical Center
New York, NY

PURPOSE

Spinal hemangioblastoma is an uncommon, but well-recognized benign hypervascular tumor, typically intramedullary and less often, intradural extramedullary in location. Extradural spinal hemangioblastomas are quite rare. Delineating certain imaging characteristics of this lesion is important in establishing a differential diagnosis. We report two sporadic cases of extradural spinal hemangioblastoma.

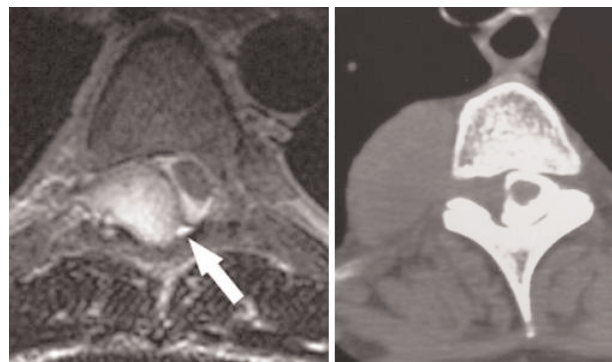
MATERIALS & METHODS

The imaging findings were reviewed in two cases of extradural spinal hemangioblastoma. In case 1, a 51-year-old male presented with worsening radicular back pain. MR imaging with gadolinium was performed with subsequent preoperative angiographic embolization for tumor devascularization. In case 2, a 62-year-old female presented with progressive midback pain. An initial CT demonstrated a right-sided spinal/paraspinal mass. A CT myelogram and MR imaging of the spine also were performed.

RESULTS

In case 1, the MR image of the spine demonstrated an intensely enhancing lesion that compressed the adjacent spinal cord and widened the right neural foramen. Associated flow voids were identified also. On T2 axial images, the right-sided mass was capped posteriorly with hyperintense epidural fat (white arrow) and caused displacement of the hypointense dura medially to the left against the

adjacent spinal cord. These findings confirmed the extradural location of the lesion. In case 2, a CT myelogram was performed in conjunction with an MR image of the thoracic spine to help elucidate the location of the lesion. The CT myelogram demonstrated a purely extradural mass extruding through a widened right neural foramen without bony destruction. The spinal cord was deviated to the left with almost complete obliteration of the intradural extramedullary space on the left side. MR imaging further characterized the hypervascularity of the mass and demonstrated associated surrounding flow voids. The lesions were confirmed to be hemangioblastomas by pathology. These two patients were screened and found not to have Von Hippel Lindau disease.



CONCLUSION

Extradural spinal hemangioblastoma is a rare hypervascular tumor, which is sometimes difficult to distinguish from a lesion located in the intradural extramedullary space. MR imaging has become a standard imaging modality for evaluating spinal lesions. The fat-cap sign and displacement of the dura are MR imaging characteristics, which help to delineate the extradural location of a lesion. When these findings are present in conjunction with flow voids, an extradural spinal hemangioblastoma should be considered.

REFERENCES

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KEY WORDS: Hemangioblastoma, extradural

Paper 283 Starting at 11:31 AM, Ending at 11:36 AM

MR Imaging of Brachial Plexopathy in a Patient with Charcot-Marie-Tooth

Jones, J. O. • Kirsch, C. • Elrington, G.

Bart's & The London NHS Trust
London, UNITED KINGDOM

PURPOSE

Charcot-Marie-Tooth (CMT) disease is the most common inherited degenerative peripheral nerve disorder; however, there are scant references of the imaging manifestations. This case presents the MR appearance of a brachial plexopathy from CMT1A with a review of the current imaging literature.

MATERIALS & METHODS

A 41 year-old female presented to her neurologist noting increasing difficulty walking over a few years and controlling the little finger of her right hand during a manicure. She had difficulty opening jars and deterioration of her handwriting. On exam a pes cavus, an areflexic right arm and marked wasting of the right hand intrinsic muscles was noted.

RESULTS

Blood work revealed a chromosome 17p11.2 duplication consistent with a diagnosis of CMT1A. A brachial plexus MR image revealed impressive thickening and enhancement of the roots, trunks, and divisions of the brachial plexus bilaterally. Patient underwent subsequent right ulnar nerve root decompression with marked improvement of symptoms.



CONCLUSION

Although much is written of the genetics and clinical manifestations of CMT, very little information is available about imaging features. Thickening of peripheral nerves is a clinical feature of CMT and occurring in up to 25% of cases. Diagnosis of CMT is made clinically with confirmatory electrophysiologic studies, nerve biopsy, and genetic testing. However, radiologists should be aware of the imaging manifestations as an important adjuvant to the diagnosis and management.

KEY WORDS: Brachial plexus, Charcot-Marie-Tooth, Plexopathy

Paper 284 Starting at 11:36 AM, Ending at 11:41 AM

Watch Your Swing: Unusual Cause of Cord Hemorrhage

Ifthikharuddin, S. F. • Monajati, A.

Rochester General Hospital
Rochester, NY

PURPOSE

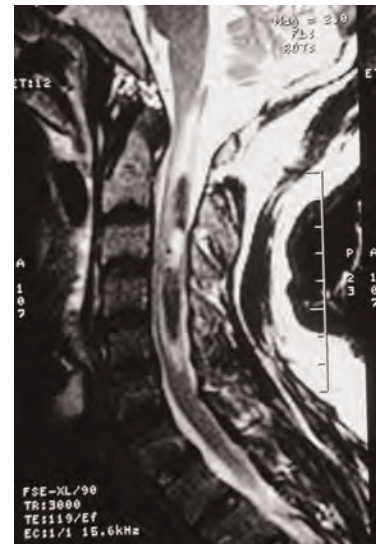
Spinal cord hemorrhage is not seen infrequently in cervical spine trauma and in association with fracture and cord contusion. Spontaneous progressive hemorrhage following rounds of golf albeit several with near complete clinical and radiologic resolution has not been reported before.

MATERIALS & METHODS

A 47-year-old previously healthy white male presented with pain in the left arm followed by progressive left arm weakness. History was significant for playing 72 holes of golf in a golf marathon the previous day. The weakness progressed to the left leg and right arm. On exam, there was flaccid paralysis of bilateral upper extremities and left lower extremity and 2/5 power in the distal right lower extremity. Vibration sense was absent on the right. There was absence of all reflexes except Babinski which was present bilaterally. The patient also complained subsequently of difficulty in speaking and shortness of breath for which he was intubated.

RESULTS

CT scan of the neck at admission showed acute hemorrhage in the cervical spinal cord. MR imaging of the cervical spine including GRE sequences showed extensive hyperacute and acute hemorrhage within the cord extending from mid C2 to mid C5 levels associated with significant surrounding edema extending to the cervicomedullary junction. There was no history of coagulopathy and coagulation tests were normal. He was treated with high dose methylprednisolone (solumedrol), with dramatic improvement in paralysis in the next 48 hours at which time he was extubated. Residual neurologic impairment after 6 days consisted of mild weakness in the left upper extremity and impaired pinprick in the thoracic dermatomes. Subsequent scans showed evolution of the hemorrhage to near total resolution. There was no evidence of a discrete mass or enhancement to suggest tumor, abnormal vessels also were not noted.



CONCLUSION

This case illustrates two important points: Massive hemorrhage within the cord even when associated with substantial edema does not necessarily indicate poor prognosis. Significant hemorrhage can occur without high impact trauma or fracture.

REFERENCES

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KEY WORDS: Spinal cord, hemorrhage

Thursday Morning

10:15 AM - 11:45 AM
Room 602 - 603

(55) ELC Workshop E: Website
 Creation for Advanced Users

– Dale A. Charletta, MD

Thursday Morning

11:50 AM - 12:50 PM
Room 611 - 612

(56) American Society of Spine
 Radiology (ASSR) Annual Business
 Meeting (Members Only)

Thursday Afternoon

1:00 PM - 2:30 PM
Ballroom 6 A

(57) Dynamic and Upright
 MRI/Sciences (ASSR)

(57a) Spinal Instability

– Luigi Manfrè, MD

(57b) Dynamic Imaging of the Posterior Elements

– J. Randy Jenkins, MD, FACR, FEC

(57c) Normal and Abnormal Disks

– Jeffrey Silber, MD

(57d) Dynamic Disk Pressure Measurements

– Kurt P. Schellhas, MD

(57e) Dynamic Vertebral Body Mechanics

– Stephen M. Belkoff, MD

Moderators: Michael I. Rothman, MD
 Bruce A. Wasserman, MD

Spinal Instability

Luigi Manfrè, MD

LEARNING OBJECTIVES

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

- 1) Describe indirect sign of micro-instability of the lumbar spine on CT scan and MR imaging
- 2) Evaluate the physiologic and pathologic CT and MR findings using an axial-loader device
- 3) Summarize the role of ligaments and muscles in determining spinal instability

PRESENTATION SUMMARY

The evolution of new deals in the treatment of spinal microinstability has overcome the old fashion conservative management in recent years. Enthusiastic results of minimal invasive surgery vs conservative management in case of spondylolisthesis are summarized by the fact that surgical immobilization restoring load sharing to the anterior column eliminate the pain coming from the disk and articular joints in 89% of patients. Nevertheless, neuroimaging of spinal instability remained, for a long time, unable to demonstrate more than simple macroscopic changes in spine morphology, and the diagnosis of spinal instability remained a "unproved

label for back pain patients," according to Nachemson. The main problem we have to face is definitely the real source of back pain in spinal instability. In 1989, Kuslich and coworkers demonstrated the endplates, the spinal processes, the articular facets to be involved, similar to disk outer nerves, in the mechanism of lumbalgia. X-ray film criteria for spinal instability, like an angle between spinal processes more than 11° when compared to adjacent segments, or antero-posterior translation of vertebral bodies more than 3.5 mm, or widening of articular facet joint space and/or facet rotation on a lateral view, or lateral tilting of the vertebral body on antero-posterior view, should not be considered the only radiologically proven pictures for the diagnosis of spinal instability. We will split our evaluation of modern neuroimaging of spinal instability into two parts: first, we will analyze "conventional" CT and MR signs, that can be demonstrated in a patient lying in the supine position when the study is performed, and then we will talk about "in vivo" dynamic CT-MR changes demonstrated by the use of an axial-loader while the neuroimaging is performed. According to Jinkins and Kaech work (see "Spinal Restabilization Procedures," DL Kaech and JR Jinkins, Eds., Elsevier 2002), in backward listhesis, 2 phases can be revealed on neuroimaging: o Phase 1, or "coarse stippling" phase, with joints effusion, with widening of intraarticular space and narrowing of spinal foramina. o Phase 2, with contact between superior articular process and the isthmus of the superior vertebral body, with bone erosion-sclerosis. In these patients, bone changes can be detected equally by CT and MR scans: however, MR imaging demonstrates bone marrow signal changes suggestive of local instability and local granulomatous tissue responsible for back pain. In the anterolisthesis, first a remodelling process of articular joints occurs ("bending"), with destruction of articular cartilage and bone marrow edema (i.e., low signal intensity on T1-weighted images and long signal intensity on very long TE scans, preferably on STIR sequences). Second, fatty degeneration of the inflamed bone marrow leads to high signal intensity of the pedicle on T1-scans, and finally severe sclerosis of the pedicle-articular processes occurs, with darkening of the signal intensity in all the sequences. However, conventional MR scans should be focused not only on vertebral evaluation, but on articular-ligaments-muscles complex too, as spinal instability can be related to local inflammatory or atrophic changes (i.e., muscle trauma, or miositis). Nevertheless, conventional CT and MR imaging of the spine suffer from the original sin that is to evaluate the spine on a load-free position (the supine position), in a patient that generally suffers from pain when the upright position is assumed: for this reason we prefer to analyze patients before and during spine compression using a special device, called "axial-loader." The axial loader device is CT and MR imaging compatible, and mimic the head-trunk load on the spine, the way we can demonstrate morphologic changes in a patient when the lumbar or cervical spine is compressed (i.e., widening or narrowing of articular spaces and foramina, movement of vertebral bodies, diskal changes, functional synovial cists, spinal root compression). Finally, new minimally invasive treatments of local pain related to spinal instability will be discussed.

Dynamic Imaging of the Posterior Elements

J. Randy Jinkins, MD, FACR, FEC

LEARNING OBJECTIVES

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

- 1) Differentiate the concepts of positional, kinetic and recumbent imaging
- 2) Define the clinical indications for recumbent, positional and kinetic imaging
- 3) Summarize the significance of upright, weight-bearing, dynamic-kinetic imaging of the spine

PRESENTATION SUMMARY

Introduction: MR imaging using commercial systems until the present has been limited to acquiring scans with patients in the recumbent position. It is a logical observation that the human condition is subject to the effects of gravity in positions other than that of recumbency. In addition, it is clear that patients experience signs and symptoms in positions other than the recumbent one. For this reason, a new fully open MR imaging unit was configured to allow upright, angled-intermediate, as well as recumbent imaging. The Stand-Up™ MRI System: Examinations were performed on an open full-body MR imaging system (Stand-Up™ MRI, Fonar Corporation, Melville, NY). The system operates at 0.6 T field strength using an electromagnet with a horizontal field, transverse to the axis of the patient's body. In addition to traditional recumbent neutral MRI (rMRI), the Stand-Up™ MRI system enabled upright neutral positional MRI (pMRI), and dynamic-kinetic MRI (kMRI). Discussion: Nondynamic upright weight-bearing MR imaging, or upright-neutral pMRI, showed a phenomenon here termed spinal column "telescoping" whereby the levels of generalized intersegmental spinal degeneration showed a collapse of the spine into itself. Consequent redundancy of the posterior diskal and ligamentous tissues of the spine as well as craniocaudal shortening of the spine associated with telescoping caused increased degrees of neural foramen stenosis on pMRI over that of rMRI. Upright extension kMRI tended to show greater degrees of neural foramen stenosis, while flexion kMRI revealed a lessening or complete resolution of this same neural foramen narrowing. These phenomena were observed only at levels of intervertebral disk degeneration (i.e., both disk desiccation and disk space narrowing). Spatial alterations also were observed in cases of sagittal plane hypermobile intersegmental spinal instability. Utilizing kMRI, it was possible to judge even minor degrees of translational hypermobile spinal instability (e.g., mobile antero- or retrolisthesis) grossly as well as by using direct region of interest measurements. These changes were accompanied by a relative worsening of the isolevel narrowing of the neural foramina. Furthermore, comparative rMRI and kMRI imaging revealed instances of posterior column intersegmental hypermobility both due to posterior spinal ligament rupture as well as to fractures of the posterior spinal elements. The fractures were observed both in the presence and absence of underlying bony abnormality. These dynamic alterations were occult on the rMRI examinations, and therefore diagnostically overlooked. Conclusions: To conclude, the potential relative beneficial aspects of upright, weight-bearing (pMRI), dynamic-kinetic (kMRI) spinal imaging on this system over that of recumbent MR imaging (rMRI) include: revelation of occult degenerative spinal disease dependent on true axial loading (i.e., weight-bearing),

unmasking of kinetic-dependent degenerative spinal disease (i.e., flexion-extension), and the potential ability to scan the patient in the position of clinically relevant signs and symptoms. Overall, it was found that rMRI underestimated the maximum degree of degenerative spinal pathology and missed altogether its dynamic nature, factors that are revealed optimally with p/kMRI.

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3. Jinkins JR, Dworkin JS, Green CA, Greenhalgh JF, Gianni M, Gelbein M, et al. **Upright, Weight-Bearing, Dynamic-Kinetic MRI of the Spine: pMRI/kMRI.** *Riv di Neuroradiol* 2002;15:333-356
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Disclosure: The author of this presentation has indicated an affiliation with Fonar Corporation: Stock options, Research grant, Speakers' bureau.

Normal and Abnormal Disks

Jeffrey Silber, MD

Jeff Silber is presently an assistant professor in the department of orthopedic surgery at North Shore-Long Island Jewish Health System affiliated with the Albert Einstein School of Medicine. He is chief of orthopedic spinal surgery at Long Island Jewish Medical Center located in New Hyde Park, Long Island, NY. He is Board Certified in Orthopaedic Surgery. Dr. Silber graduated number one from New York Medical College in 1995 and completed an orthopedic residency at The University of Pennsylvania in 2000. He then completed a combined orthopedic and neurosurgical spine fellowship at Thomas Jefferson University in 2001. Prior to attending medical school he also achieved a doctorate in chiropractic. He has over 30 peer-reviewed manuscripts and has coauthored many chapters dealing with spinal-related conditions. He has presented nationally including the American Academy of Orthopedic Surgery, and North American Spine Society and has received research awards including the Cervical Spine Research Society award.

LEARNING OBJECTIVES

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

- 1) Differentiate the normal and abnormal functions of the intervertebral disk
- 2) Define the basic pathophysiology of intervertebral disk degeneration
- 3) Discuss the design and function of an intervertebral disk replacement
- 4) Measure outcomes and challenges, and recognize the future of intervertebral disk replacements

PRESENTATION SUMMARY

Intervertebral disk degeneration is a ubiquitous problem producing pain and disability affecting almost every individual throughout their lifetime. This has resulted in an enormous loss of workdays and an expenditure of billions of dollars annually. Recent advances in the study of the intervertebral disk has led to a better understanding of normal and abnormal disk biology, and biomechanics. Furthermore, these advances have increased our understanding of the pathophysiology of disk degeneration, leading to increased interest in early diagnosis, prevention, and management of this condition including intervertebral disk replacements. Disk replacements are being performed with increasing frequency both in Europe and more recently in the United States. The challenges of these devices, which are still not completely defined, include the composition compatibility in humans pertaining to long-term particulate debris and failure, biomechanical similarities to the normal human intervertebral disk, and adjacent level intervertebral disk degeneration. Objectives to be covered include lumbar intervertebral disk anatomy, biology, biomechanics, and motion in the normal and degenerated (abnormal) disk, the process of disk degeneration, and the current surgical management with an emphasis on intervertebral disk replacement composition, design biomechanics, function, outcomes, complications, and future challenges and considerations.

Disclosure: The author of the presentation has indicated that he will be discussing/presenting an unapproved/investigative use of Intervertebral disc replacement

Dynamic Disk Pressure Measurements

Kurt P. Schellhas, MD

LEARNING OBJECTIVES

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

- 1) Describe normal thoracic disk biomechanics
- 2) Describe technique of thoracic disk puncture and introduction of diagnostic and potentially therapeutic devices

PRESENTATION SUMMARY

This study was undertaken to measure thoracic intervertebral disk pressure (IDP) in healthy disks within asymptomatic volunteers during various physical maneuvers. Six healthy asymptomatic volunteers (4 male, 2 female; age 19-47 years) underwent high field magnetic resonance (MR) imaging of the thoracic spine, followed by intradiskal pressure (IDP) measurement in either one or two thoracic disks from the mid (T6-7 or T7-8) and/or lower (T9-10 or T10-11) thoracic regions. IDP measurement was accomplished using a custom-designed needle-mounted thin film metal diaphragm

pressure transducer (Gaeltec, Isle of Skye, Scotland). The pressure monitoring device was introduced into each thoracic disk by a procedural neuroradiologist thoroughly experienced in thoracic diskography (1-3). IDP was measured with the patient lying prone in lateral decubitus, sitting, standing, forward bending, side bending, in valsalva and holding hand weights. There was remarkable uniformity in IDP measurements between individual disks and subjects. The highest pressures were recorded from lower thoracic disks with the subjects holding 20 kg weights in each hand with the arms flexed. The lowest pressures were recorded in lower thoracic disks with the subjects prone. Thoracic IDP measurements vary predictably with certain maneuvers. Lifting with the upper extremities particularly raises thoracic IDP. The clinical ramifications of this data will be discussed.

REFERENCES

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Dynamic Vertebral Body Mechanics

Stephen M. Belkoff, MD

Dr. Belkoff received his Ph.D. in applied mechanics from Michigan State University. He is an associate professor in the Department of Orthopaedic Surgery and has an adjunct appointment in the Department of Mechanical Engineering at The Johns Hopkins University. Dr. Belkoff has conducted research and published in the areas hard and soft tissue mechanics, as well as trauma biomechanics and fracture fixation. Dr. Belkoff also has been active in conducting basic research on vertebroplasty.

LEARNING OBJECTIVES

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

- 1) Explain the structural support the spine provides the human body
- 2) Identify the relative contribution that the cortex and cancellous interior provide the vertebral body and how the relative contribution changes with age
- 3) Explain the structure/function of spinal ligaments
- 4) Describe the concept of coupled motion

PRESENTATION SUMMARY

The purpose of the presentation is to review basic biomechanics of the spine. We will discuss how the spine is able to bear the load of the torso while allowing for flexibility to conduct the activities of daily living. The relative load-bearing roles played by vertebral body cancellous and cortical bone will be presented. How their roles change with age will be discussed, especially in relation to osteoporosis. The mechanical/structural implications of osteoporosis will be explained. The effect of normal vs degenerated intervertebral disk on endplate mechanics and axial load transmission will be discussed. The

structure and function of spinal ligaments will be presented. The concept of viscoelasticity (how loading rate affects the mechanical behavior of tissue) will be reviewed and the natural damage prevention mechanism that viscoelasticity affords ligaments and other soft tissue will be explained. Normal spine kinematics and range of motion also will be reviewed.

Thursday Afternoon

1:00 PM - 2:30 PM

Ballroom 6 B/C

(58) Atherosclerosis (ASITN)

(58a) Patient Selection

— Colin P. Derdeyn, MD

(58b) Intracranial Angioplasty/Stenting

— Joan C. Wojak, MD

(58c) Cervical Carotid Disease

— John J. Connors, III, MD

Moderators: Gary M. Nesbit, MD
Kieran P. J. Murphy, MD

Patient Selection

Colin P. Derdeyn, MD

LEARNING OBJECTIVES

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

- 1) Recognize the importance of ischemic symptoms as a predictor of stroke risk in patients with atherosclerotic disease
- 2) Describe the role of cerebral hemodynamics as predictors of stroke risk

PRESENTATION SUMMARY

Two critical factors are important in determining whether a patient with atherosclerotic cerebrovascular occlusive disease is a candidate for endovascular or surgical intervention: the presence of ischemic symptoms referable to the lesion and the degree of stenosis. The status of the collateral circulation - the presence or absence of hemodynamic impairment - is a third important factor that likely will come to play a role in patient selection, particularly for patients with complete carotid occlusion and possibly for patients with asymptomatic stenoses. In this talk, we will first review the mechanisms by which these lesions cause or predispose for ischemic stroke. Both embolic and hemodynamic factors are involved. We then will review the natural history of symptomatic and asymptomatic cervical and cerebral occlusive disease. Following this we will review the results of surgical and endovascular clinical

cal trials for these different lesions as they pertain to patient selection for endovascular revascularization.

Disclosure: The author of the presentation has indicated that he will be discussing/presenting an unapproved/investigative use of O-15 PET studies, XeCT, Carotid Stent.

Intracranial Angioplasty/Stenting

Joan C. Wojak, MD

LEARNING OBJECTIVES

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

- 1) Assess the natural history of symptomatic intracranial atherosclerosis and the unsatisfactory impact of medical therapy and surgical revascularization
- 2) Describe the potential short- and long-term benefits of intracranial angioplasty with or without stenting
- 3) Discuss the limitations of this procedure
- 4) Identify those patients that might benefit from this procedure

PRESENTATION SUMMARY

The incidence of hemodynamically significant atherosclerotic intracranial vascular disease is underappreciated clinically and diagnostically. Between 5% and 10% of strokes are thought to be caused directly by intracranial large vessel atherosclerotic disease. The estimated risk of stroke in the setting of intracranial stenosis varies from approximately 7% to 40% per year; many patients do not experience warning transient ischemic attacks. Medical therapy does not result in a satisfactory decrease in the stroke risk. Extracranial-intracranial bypass surgery also has been shown to be ineffective, and in some cases detrimental. The evolution of intracranial angioplasty and stenting for the treatment of intracranial atherosclerosis will be discussed. A single-center experience will be presented. A series of 99 patients underwent intracranial angioplasty and/or stenting (19 lesions were stented) for the treatment or prevention of stroke at a single institution, with up to 7-year follow-up (mean 1.1 months). The technical success rate was 93%; 5 lesions could not be reached and there were two periprocedural vessel ruptures or perforations accounting for the only two deaths in the series. There was one additional wire perforation with good outcome, 2 periprocedural ischemic strokes and one small intraparenchymal hematoma; all with eventual good outcome. The incidence of subsequent stroke in the distribution of the target lesion was 4%, and the restenosis rate was 26% (7/24 symptomatic, 15 retreated). All restenoses occurred within 16 months (mean 5.3 months). These results will be discussed in greater detail. The presented data demonstrate that, with current technique and equipment, intracranial angioplasty/stenting can be performed safely and this may be an efficacious therapy for intracranial atherosclerosis.

Disclosure: The author of the presentation has indicated that she will be discussing/presenting an unapproved/investigative use of Angioplasty/stents in the intracranial. The stents are made by Boston Scientific, Cordis Neurovascular, Gundant.

Cervical Carotid Disease

John J. Connors, III, MD

Thursday Afternoon

1:00 PM - 2:00 PM

Room 606 - 609

(59) ELC Lecture J: Advanced Imaging Processing in MR Imaging

— Todd B. Parrish, PhD

Thursday Afternoon

2:00 PM - 2:30 PM

Room 611 - 612

(59A) National Library of Medicine (NLM): PUBMED[®]/MEDLINE Short Demonstration

— Linda Milgrom

Thursday Afternoon

3:00 PM - 4:30 PM

Ballroom 6 B/C

(60a) Adult Brain: General (Scientific Papers 285 - 296)

See also Parallel Sessions

(60b) Interventional: Aneurysms

(60c) Adult Brain: General and Diffusion Imaging

(60d) Adult Brain: General and 3.0 T

Moderators: Dennis K. Shibata, MD
Erin M. Simon, MD, OTR

Paper 285 Starting at 3:00 PM, Ending at 3:08 PM**Acute Infarct Detection in a Large Emergency Department Series during the Year 2000: Accuracy of Perfusion-Weighted Imaging**

Mullins, M. E.¹ • Cullen, S.² • Lev, M.¹ • Schaefer, P. W.¹ • He, J.¹ • Gonzalez, R.¹

¹Massachusetts General Hospital, Boston, MA, ²University of California San Francisco, San Francisco, CA

PURPOSE

To assess the sensitivity, specificity, and accuracy of perfusion-weighted imaging (PWI) in the detection of acute infarct.

MATERIALS & METHODS

The medical records of 479 consecutive patients with admitting diagnoses of acute stroke were reviewed retrospectively for (1) diagnostic imaging results and (2) final discharge diagnosis. All imaging was performed within 48 hours of stroke onset. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of infarct detection were calculated. Twenty-two patients with final discharge diagnosis of transient ischemic attack were excluded. All MR examinations were performed with diffusion-weighted imaging (DWI).

RESULTS

Thirty-one patients were identified who received PWI at admission. Ictal onset time was known for 20 patients with a mean time of presentation to the emergency department of 2 hours and 31 minutes postictus. In patients with known ictal onset time, PWI was performed with a mean time of 5 hours and 5 minutes postictus. For PWI, 0 cases were equivocal. The sensitivity of PWI for the detection of acute infarct was 96%, specificity 100%, PPV 100%, NPV 75%, and accuracy was 97%.

CONCLUSION

Perfusion-weighted imaging in a large patient population offers improved accuracy and negative predictive value compared to statistics previously reported for head CT, CT angiography, conventional MR imaging and diffusion-weighted imaging alone for the detection of acute infarct.

KEY WORDS: Stroke, perfusion-weighted imaging, diffusion-weighted imaging

Paper 286 Starting at 3:08 PM, Ending at 3:16 PM**Gradient-Echo T2*-Weighted Prominence of the Basal Vein of Rosenthal in MCA Ischemia**

Liebeskind, D. S. • Ances, B. M. • Weigle, J. B. • Hurst, R. W. • Melhem, E. R.

University of Pennsylvania
Philadelphia, PA

PURPOSE

Susceptibility-weighted MR sequences may demonstrate signal loss associated with deoxyhemoglobin in acute ischemia. Such T2*-weighted hypointensity may be maximal in venous structures draining ischemic regions. We

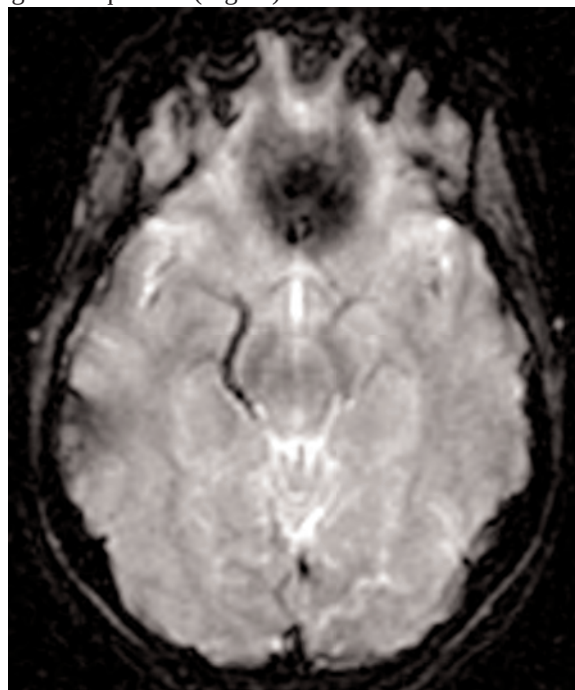
describe T2*-weighted prominence of the Basal Vein of Rosenthal in acute and chronic MCA ischemia and hypothesized that this finding reflects the presence of a proximal arterial occlusion.

MATERIALS & METHODS

Retrospective review of MR imaging/MR angiography acquired in 83 cases (median age 65 years, range 18-89 years; 46:37 M:F) of MCA stroke and 24 cases (median age 35 years, range 19-67 years; 8:16 M:F) of moyamoya syndrome. The presence of hypointensity in the Basal Vein of Rosenthal was noted on gradient-echo T2*-weighted sequences. The presence of proximal arterial occlusion was noted on MR angiography. Multivariate logistic regression analysis explored predictors for hypointensity of the Basal Vein of Rosenthal.

RESULTS

Prominent hypointensity in the Basal Vein of Rosenthal was noted in 27/83 (33%) cases of MCA stroke imaged with a median delay of 2 days (range 0-17 days) from stroke onset. This finding was observed on the side of the ischemic hemisphere in 14/14 (100%) left MCA strokes and 13/13 (100%) right MCA strokes. Independent predictors for this finding included decreasing delay of imaging from stroke onset ($p = 0.03$) and the presence of proximal MCA occlusion ($p = 0.04$). In the setting of chronic ischemia associated with moyamoya syndrome, the Basal Vein of Rosenthal was frequently apparent as a large, hypointense structure on T2*-weighted sequences (Figure).



Phase-mismatching suggestive of increased venous blood flow also was associated frequently with this finding. T2*-weighted hypointensity of the Basal Vein of Rosenthal was noted to be unilateral in 12/24 (50%) cases, bilateral in 9/24 (38%), and absent in 3/24 (12%). Bilateral hypointensity of this venous structure was always associated with bilateral arterial stenoses. Unilateral hypointensity of this vein corresponded to the symptomatic hemisphere in 4 cases with bilateral moyamoya and the side of arterial stenosis in cases of unilateral moyamoya.

CONCLUSION

T2*-weighted hypointensity of the Basal Vein of Rosenthal may reflect increased venous return of deoxygenated blood associated with acute or chronic MCA ischemia and the presence of a proximal arterial occlusion.

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KEY WORDS: Ischemia, deoxygenation, susceptibility-weighted

Paper 287 Starting at 3:16 PM, Ending at 3:24 PM

StrokeCheck 2004: 2004 Update to the StrokeCheck Stroke Awareness and Educational Program

Agran, S. D.

Sun City Imaging
Scottsdale, AZ

StrokeCheck is an ASNR and ASA sponsored and SIR endorsed stroke awareness and educational program, created to help educate the public regarding stroke warning signs, stroke risk and risk factor modification, and emphasizing that stroke is an emergency requiring 911 action. StrokeCheck was modelled after the highly successful Legs for Life program, and is in its fourth year. It previously has been performed successfully in Phoenix, Denver, Albuquerque and various other sites. The 2004 expansion will be discussed, with the results from the recent May 2004 StrokeCheck program announced

KEY WORDS: StrokeCheck, education, stroke

Paper 288 Starting at 3:24 PM, Ending at 3:32 PM

Processing and Interpretation Times of CT Angiogram and CT Perfusion Studies in Acute Stroke

Srinivasan, A. • Goyal, M. • Prasad, J. • Lum, C. • Nguyen, T. • Miller, W.

The Ottawa Hospital
Ottawa, ON, CANADA

PURPOSE

The purpose of this study was to determine the mean time for obtaining, processing, and interpreting CT perfusion (CTP) and CT angiogram (CTA) images in patients presenting with acute stroke. We also compared the processing and interpretation times of CTA and CTP studies among three groups namely radiology residents, neuroradiology fellows, and consultant neuroradiologists with at least 5 years of experience.

MATERIALS & METHODS

Ten patients presenting with acute stroke within 6 hours of onset from May 2003 to November 2003 formed the study material. CTA was performed from the aortic arch to the circle of Willis using 100-120 ml Iohexol injected at 3ml/sec and a delay of 20 seconds. CTP was performed covering a 2

cm thick area at the level of the basal ganglia. The mean time of acquisition of CTA and CTP studies after performing the initial plain head CT scan in all patients was calculated. Two residents (PGY3, PGY4), two neuroradiology fellows, and four consultant neuroradiologists each were presented with a short clinical history and then 10 CTA and CTP studies for processing and interpretation. Prior to their entry into the study, both the residents were trained to process and interpret CTA and CTP studies with 10 different cases. All readers had to process the images, interpret the images (for the presence or absence of any intracranial clot and penumbra), and save them. All processing was done on the GE Advantage Windows workstation.

RESULTS

The mean time for acquisition of CTA and CTP studies in the ten patients was 14.6 ± 5.9 minutes. The time taken for CTA processing and interpretation for residents, fellows, and consultant neuroradiologists was 2.3 ± 1.3 min, 1.6 ± 0.4 min, and 1.5 ± 0.7 min, respectively. The time required for CTP processing and interpretation by the same groups was 5.2 ± 1.7 min, 4.5 ± 1.5 min, and 4.1 ± 1.1 min, respectively. There was no difference in interpretation between all readers. There was a statistically significant difference of means between the resident group and the consultant neuroradiologists in the CTA and CTP processing and interpretation times ($p = 0.01$, $p = 0.01$, respectively) but no statistical difference between means of the fellow and consultant groups ($p = 0.21$, $p = 0.39$, respectively).

CONCLUSION

The mean time for acquisition of CTA and CTP studies in acute stroke patients is approximately 15 minutes. The time taken for CTA and CTP processing and interpretation is under 10 minutes for all groups namely residents, fellows, and consultant neuroradiologists. Thus CTA and CTP studies can be performed, processed, and interpreted quickly in an acute stroke setting and provide necessary information for planning therapeutic strategy.

KEY WORDS: CT perfusion, stroke, timing

Paper 289 Starting at 3:32 PM, Ending at 3:40 PM

Detection of Blood-Brain Barrier Leakage in Early Acute Stroke Using Dynamic Contrast-Enhanced MR Imaging

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¹University Health Network, Toronto, ON, CANADA, ²The University of Toronto, Toronto, ON, CANADA, ³The Toronto Western Hospital, Toronto, ON, CANADA

PURPOSE

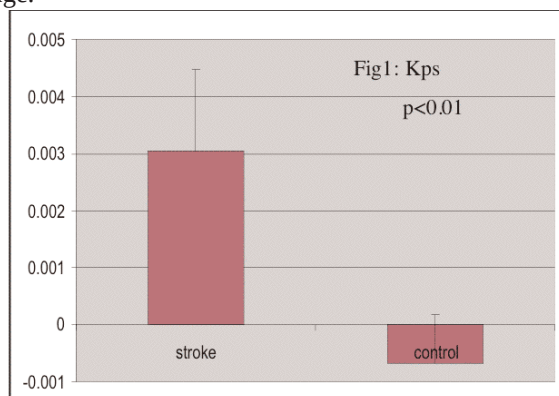
The major risk of thrombolysis in the acute ischemic stroke setting is hemorrhage. Little is known about the specific mechanisms that lead to extravasation of blood into the tissue. However, we believe that the loss of blood-brain barrier (BBB) integrity is important and may lead to hemorrhagic transformation. Therefore the ability to detect defects in this barrier may provide a sensible indicator to judge this risk. The purpose of this study was to determine evidence of BBB leakage using dynamic contrast-enhanced MR imaging (DCI).

MATERIALS & METHODS

Seven patients (3 female, 4 male, age range 38-80 years) with acute ischemic stroke were examined within 24 hours of symptom onset using an acute stroke protocol consisting of anatomical, diffusion and perfusion imaging, and contrast-enhanced MR angiography (MRA). In addition, a 3D GE DCI exam was performed to assess permeability/BBB leakage. All imaging was performed on a 1.5 T GE Signa MR system equipped with echospeed gradients and a standard neurovascular head coil. Imaging parameters for the 3D GE acquisition were as follows: FOV 240 mm, 128 x 128 matrix, FA = 20 deg, slice thickness 7 mm, TR = 5.9 ms, TE = 1.5 ms. Total acquisition time was 4:48 min for a collection of 31 volumes. Contrast media (total volume of 15 cc Gd DTPA) was injected as a bolus after volume 2 of the 3D acquisitions. Data was transferred to an independent workstation for analysis. Parametric maps of fractional blood volume (fBV) and permeability (kPS) were calculated as described previously by Roberts et al (1). Two ROIs were selected; one placed on the diffusion abnormality (ADC) and the second placed on the same location in the contralateral normal hemisphere. Mean and STD were recorded and examined for statistical significance using a 2 tailed paired Student's t-test.

RESULTS

Results are displayed in Figure 1 and show a significant increase in microvascular permeability (Kps) for the lesion (0.0032 ml/100 g/min +/- 0.0027 compared to -0.00088 mls/100 g/min +/- 0.00243). Fractional blood volume (fBV) was not significantly different for both ROIs (0.0701 +/- 0.751 for the lesion compared to 0.0448 +/- 0.038 for the control ROI), although showed a tendency towards elevation in the lesion consistent with vasodilation. One case showed enhancement in the acute phase and then went on to hemorrhage.



CONCLUSION

These findings suggest that BBB deficiency can be assessed in acute stroke using quantitative dynamic contrast-enhanced MR imaging. Blood-brain barrier defects were found in all cases indicating hemorrhagic potential. The relationship between these defects and subsequent risk may be possible using this technique but additional work is required to establish this relationship.

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KEY WORDS: Ischemic stroke, dynamic contrast-enhanced MR imaging, permeability

Paper 290 Starting at 3:40 PM, Ending at 3:48 PM

Differences in Brain Structure in the Deaf on MR Imaging Studied with Voxel-Based Morphometry

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PURPOSE

The loss of a major sensory input at an early age has been shown in animal models to result in alterations in neuronal connectivity and cortical structure. The purpose of this study was compare structural brain MR scans of the deaf vs hearing using an automated image-processing technique, voxel-based morphometry (VBM).

MATERIALS & METHODS

Fifty-three right-handed prelingually deaf students from a deaf college (34 male, 19 female, average age 21) were compared with 51 hearing right-handed subjects (31 male, 20 female, average age 25). On a 1.5 T MR scanner, 3D SPGR imaging was performed with 1.5 mm contiguous axial T1-weighted images. An optimized protocol for VBM analysis was performed using SPM2 (1). Initial gray matter, white matter, and fluid segmentations were spatially normalized and then these deformation parameters were applied to the original images which then were segmented again. The images then were modulated for volume changes and subject to smoothing using a 12 mm kernel. A t-test statistic then was applied between the two groups.

RESULTS

White matter analysis revealed a focus in the left superior temporal gyrus with 3 cluster, 2 of which (-61, -20, 5 and 50, -12, 2) were of statistical significance ($P < .036, .039$) when using the family-wise correction for multiple comparisons. These foci correspond to white matter underlying Brodman areas 22, 42, and 41 and are inferior to Heschl's gyrus. Gray matter analysis revealed only one focus which was at the border of statistical significance ($P < .059$) in the left superior frontal gyrus (-13, 13, 74) in Brodman area 6, corresponding to premotor cortex.

CONCLUSION

These results support the hypothesis that there are gross alterations in brain anatomy as an adaptation to early deafness. The WM alteration in the posterior aspect of the left superior temporal gyrus may represent decreased volume of auditory tracts although the precise localization appeared centered inferior to primary auditory cortex and the left lateralization may be related to speech. The GM finding of a difference in the left premotor cortex may be an adaptation to hand-motor processing in sign language. These anatomical differences although subtle likely reflect deeper functional alterations which may be important clinically in pre-operative planning and more generally in understanding plasticity in brain development. In comparison to a recent report on anatomical MR imaging on 12 deaf subjects (2), the present larger group analysis reveals a difference in the temporal lobe not seen in the smaller study.

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KEY WORDS: Brain, anatomy, deafness

ACKNOWLEDGMENTS

The National Technical Institute of the Deaf at the Rochester Institute of Technology, Rochester, NY provided assistance with subjects.

Rachel Yotter, Electrical Engineering, University of Washington, assisted with data analysis.

Paper 291 Starting at 3:48 PM, Ending at 3:56 PM

Detection of Cortical Multiple Sclerosis Lesions In Vivo by Averaging Serial 3D T1 MR Imaging

Butman, J. A.¹ • Bagnato, F.² • Richert, N. D.¹ • Stone, R. D.¹ • Gupta, S.¹ • Ohayon, J. M.¹ • Frank, J. A.¹ • McFarland, H. F.²

¹Warren G. Magnuson Clinical Center, National Institutes of Health, Bethesda, MD, ²Neuroimmunology Branch, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, MD

PURPOSE

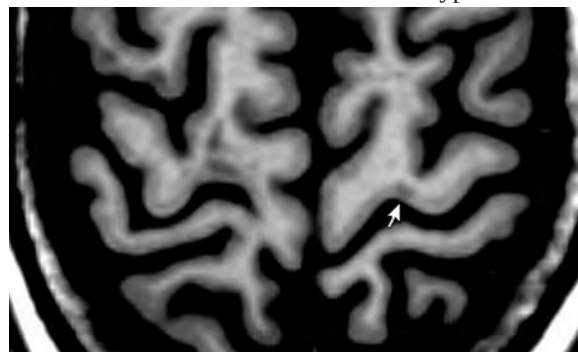
The supposition that multiple sclerosis (MS) is pure white matter (WM) disease has been questioned, as recent studies show pathology in gray matter (GM) as well as WM. Although postmortem studies demonstrate cortical lesions by MR imaging, demonstration of these lesions by in vivo MR imaging remains challenging. By averaging high-resolution 3D T1 spoiled-gradient SPGR datasets, we attempted to detect cortical lesions in a group of 13 MS patients with relapsing remitting multiple sclerosis.

MATERIALS & METHODS

Thirteen patients (6 male, 7 females, age 37.1 ± 9.4 years) with a 7.1 ± 8.3 year history of relapsing-remitting MS with Expanded Disability Status Scores 2.4 ± 0.9 were imaged monthly over 6 to 19 months (11.3 ± 3.9). Comprehensive brain MR images were performed at 1.5 T using a quadrature head coil (GE Medical Systems, Milwaukee, WI) including 3D T1 SPGR sequences. Contrast parameters were: TR/TE/flip angle $9/2/20^\circ$ and geometric parameters were: 256×256 matrix, 24 cm field of view, 1.3-1.4 mm slice thickness with a single 128-slice acquisition of 5 minutes. A within-subject rigid body 6 parameter coregistration of these datasets was performed with FLIRT (FMRIB, Oxford) using a cross-correlation cost function. These coregistered datasets were averaged over 6-19 MR volumes obtained in each patient in order to generate single mean image in each patient. For the purpose of this study, we counted lesions which appeared to be centered in GM as cortical lesions, allowing for some extension into juxtacortical white matter.

RESULTS

Gray matter lesions largely confined to the cortex were identified on mean images [e.g., lesion in motor strip, Figure 1 (arrow)]. Overall, 23 cortical GM lesions were identified in 8 (61%) patients. In addition, 2 lesions were detected in the thalamus and 2 lesions were found in the hypothalamus.



CONCLUSION

By averaging from 6 to 19 3D T1 SPGR datasets, we show evidence of lesions largely confined to GM of the cerebral cortex not clearly apparent on data obtained from a single MR scan. Coregistration was successful due to the nearly isotropic voxel size. Thus, the mean images were equivalent to performing MR imaging with 6-19 excitations, with commensurate improvements in signal-to-noise ratios. Although lesion to background contrast is not high on T1-weighted sequences relative to long TR sequences, the reduction in noise from averaging made both GM and WM lesions is apparent. Because data were obtained monthly for nearly 2 years in some cases, it is clear that some lesions changed over the averaged datasets and the average image may not describe these lesions appropriately. However, for lesions that remained stable over this time, a marked improvement in lesion contrast to noise was seen. Further study to optimize MR sequences and postprocessing to demonstrate these cortical lesions is warranted.

KEY WORDS: Cortex, thalamus, image processing

Paper 292 Starting at 3:56 PM, Ending at 4:04 PM

Volumetric Measurement and Spatial Distribution of Cerebrospinal Fluid in Dementing Disorders: A Differential Diagnosis Method?

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Rome, ITALY

PURPOSE

To find a standardized imaging method to distinguish among three dementing disorders - Alzheimer's disease, fronto-temporal dementia, normal pressure hydrocephalus - on the basis of CSF volume and spatial distribution by means of a voxel-based morphometry technique.

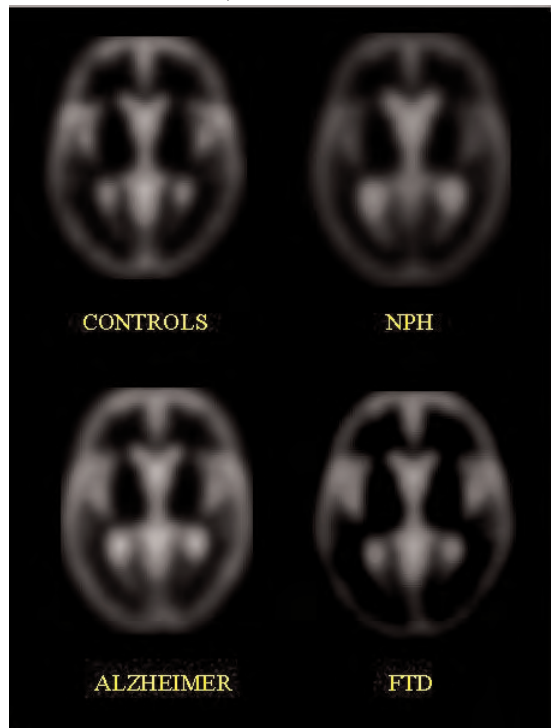
MATERIALS & METHODS

We studied three groups of patients: 12 patients affected by Alzheimer's disease (AD) according to NINCDS-ADRDA criteria (MMSE: mean $\pm$ sd = 21.51 ± 6.6 ; range = 8-27); 6

patients affected by fronto-temporal dementia (FTD), according to LUND and MANCHESTER criteria (MMSE: mean $\pm$ sd = 25.33 ± 3.8 ; range = 22-30); 7 patients with suspected normal-pressure hydrocephalus (NPH) (MMSE: mean $\pm$ sd = 22.1 ± 5.5 ; range = 11-29), who presented the clinical triad of dementia, gait disturbance, and urinary incontinence. Eight healthy controls (with normal memory performance and without vascular lesions at MR imaging) were studied. T1-weighted, volumetric MPRAGE MR scans were performed on a 1.5 T magnet yielding 150 contiguous 0.80 mm axial slices. Analysis was performed by using SPM99 running in MATLAB 5.0. The images were analyzed with optimized method by Good et al.(2000). Cerebrospinal fluid fractional volumes were calculated; images indicating the mean distribution of CSF were analyzed visually as well.

RESULTS

Mean CSF images suggested that CSF spatial distribution is specific for each dementing disorder. Alzheimer's disease showed a diffuse dilatation in SSA spaces, FTD a fronto-temporal SSA spaces dilatation whereas NPH showed enlarged ventricular system without envelopment of SSA spaces. These results were confirmed by CSF fractional volumes (AD CSF: 0.251, ventricles: 0.0342, SSA: 0.207; FTD CSF: 0.233, ventricles: 0.0331, SSA: 0.2; NPH CSF: 0.266, ventricles: 0.0671, SSA: 0.205; Controls CSF: 0.201, ventricles: 0.0189, SSA: 0.181).



CONCLUSION

Voxel-based morphology is a very sensible technique to find CSF spatial distribution in dementing disorders. Automated methods to describe the severity and distribution of cerebral atrophy can provide diagnostic information in the classification of degenerative and nondegenerative diseases leading to dementia. This approach confirmed that this kind of analysis can be complementary to clinical information and useful in the differential diagnosis among dementing diseases.

KEY WORDS: Cerebrospinal fluid, cerebral atrophy, voxel-based morphometry

Paper 293 Starting at 4:04 PM, Ending at 4:12 PM

Cerebral Blood Volume Maps Generated T1-Weighted Images Are Superior to T2*-Based Maps for Surgical Planning Applications

Patankar, T. A. F. • Haroon, H. A. • Zhu, X. • Li, K. • Jackson, A.

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Manchester, UNITED KINGDOM

PURPOSE

There is close relationship in glioma between regional histologic grade and cerebral blood volume (CBV) as measured on MR imaging. This makes CBV maps desirable for therapeutic planning and surgical guidance. Classically, CBV maps are obtained from T2*-weighted data (T2*-CBV). We recently described a novel method to calculate CBV maps from dynamic contrast-enhanced T1-weighted data (T1-CBV) using decomposition technique to separate changes in intravascular and extravascular contrast concentration and produces parametric maps of both the volume transfer constant K^{trans} and CBV. Our technique has higher through plane spatial resolution, reduced spatial distortion, and simultaneous provision of K^{trans} . If the technique is to form a sustainable alternative to T2*-CBV mapping then it should provide comparable biological information. This study tests the hypothesis that T1-CBV and T2*-CBV maps in cerebral tumors provide equivalent values of CBV in terms of magnitude and distribution.

MATERIALS & METHODS

Ten patients with histologic confirmation of cerebral neoplasms (9 gliomas, 1 metastasis) were studied. Imaging was performed at 1.5 T and T1-CBV maps were calculated from a 3D T1-weighted-FFE sequence (128×128 matrix, 25 slices, 230 mm field of view, 3 mm slice thickness, TR = 4.2 ms, TE = 1.2 ms) with 3 precontrast data sets acquired at flip angles of 2°, 10°, and 35°; followed by a dynamic contrast-enhanced acquisition at 35° with a temporal resolution of 5 s. Contrast (0.1 mmol/kg of Gd-DTPA-BMA) was injected into an antecubital vein at a rate of 4 mls/s using a power injector. T2*-CBV maps were calculated from a 2D T2*-weighted field echo sequence with segmented EPI acquisition (128×128 matrix, 9 slices, 230 mm field of view, 6 mm slice thickness, TR = 440 ms, TE = 30 ms) with a temporal resolution of 1.8 s. T2* acquisitions were performed 5-10 minutes after T1 acquisitions to provide preenhancement and reduction of relaxivity effects. Direct coregistration of T1- and T2*-weighted maps was not possible due to susceptibility based spatial distortions in T2*-CBV maps; however pixel-by-pixel comparison was performed using a nonlinear optimized matching technique. Regions of interest were drawn manually on visually matching slice positions and orientations.

RESULTS

Median T1 and T2* CBV measurements in enhancing tumor region of interest showed good correlation ($R = 0.65$, $P < 0.05$). Pixel by pixel comparisons showed good correlation across the measurement range. A visually appreciable spatial correlation between the maps also was clearly evident. Blood vessels appear larger than their actual size on T2*-CBV maps and perivascular regions show clear loss of correlation with T1 values on pixel-by-pixel comparison.

CONCLUSION

Measured values from T1-CBV maps correlate well with T2*-CBV maps, both in terms of median measurements from tumor tissue and on pixel-by-pixel comparison. Spatial distortion in regions of large blood vessels seen in susceptibility based contrast techniques is eliminated and makes T1-CBV maps preferable for surgical planning applications. This supports our hypothesis that T1-CBV and T2*-CBV maps provide biological information in terms of both magnitude and distribution of CBV with the advantages of reduced image distortion and simultaneous measurement of Ktrans.

KEY WORDS: Gliomas, MR perfusion, cerebral blood volume

Paper 294 Starting at 4:12 PM, Ending at 4:20 PM

High Resolution Anatomical and Physiologic Imaging of the Optic Nerve and Optic Chiasm at 3 T

Vinogradov, E. • Hackney, D. B. • Smith, D. R. • Marquis, R. • Lenkinski, R. E.

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Boston, MA

PURPOSE

Optic neuritis is often the first symptoms of multiple sclerosis (MS). To better characterize neural injury of MS we have implemented high resolution imaging of the optic nerve (ON) and the optic chiasm (OC) at 3 T. Our approach involves obtaining high resolution anatomical MR images as well as physiologic images of these structures. Previous studies of MS conducted at 1.5 T (1-6) have demonstrated the potential diagnostic and prognostic values of MR imaging of ON at MS. In this work we have obtained high resolution anatomical and MT images of the ON and OC.

MATERIALS & METHODS

Imaging was performed on the 3 T scanner (Signa LX, General Electric, Waukesha, WI). First, high resolution anatomical images were obtained employing a custom-designed head coil. This coil consists of a coil array (25 cm diameter) and contains four 30 ~ 30 cm squared coils. Oblique axial and oblique sagittal fast-spin echo (FSE) images were acquired with 1.5 mm slice thickness and FOV 18 ~ 18cm. Other imaging parameters were TR/TE = 5400/102.2, NEX = 4, 512 ~ 256 matrix size, and TR/TE = 5417/96.5, NEX = 3, 512 ~ 384 matrix size for axial and sagittal images, respectively. MT imaging was performed with 3D TOF GRE and using 1.5 mm slice thickness, FOV 24 ~ 18 cm, 256 ~ 256 matrix size, TR/TE = 200/2.5 ms, flip angle 20 degrees, NEX = 1, FOV 24 ~ 18 cm, 128 ~ 128 matrix size, 3 mm slice thickness. The MT pulse was optimized to achieve a maximal MT contrast at RF offset of 1200 Hz and was equal to 10 msec. The magnetization transfer ratios (MTR) were measured at the regions of interest by manual calculation.

RESULTS

The ON and OC were visualized clearly in the FSE images acquired. The use of a high sensitivity four-channel coil and 3 T field allows obtaining high-resolution anatomical images, with the in-plane resolution as low as 352 x 469 microns. This resolution enables clear and detailed demon-

stration of ON and OC in a relatively short scan time of 5 min (sagittal images) to 6 min (axial images). MT contrast images were calculated by subtracting the MT presaturated image from the reference image. MT images were obtained with a slice thickness of 1.5 mm and in-plane resolution of 938 x 938 microns in 10 min.

CONCLUSION

We have acquired high resolution anatomical and MT images at 3 T with slice thicknesses as low as 1.5 mm and submillimeter in-plane resolution. High spatial resolution MT experiments were performed at 3 T within SAR guidelines. These techniques will be applicable to MR imaging of ON and OC damage in MS.

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KEY WORDS: High resolution, optic nerve, magnetization transfer

Paper 295 Starting at 4:20 PM, Ending at 4:25 PM

Diffusion-Weighted Imaging of Delayed Postanoxic Leukoencephalopathy with Pathologic Correlation

Moritani, T. • Germin, B. • Hiwatashi, A. • Ketonen, L. • Wang, H. • Ekholm, S. • Westesson, P.

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Rochester, NY

PURPOSE

To report a case delayed postanoxic leukoencephalopathy on diffusion-weighted imaging, with pathologic correlation.

MATERIALS & METHODS

A 53-year-old man was found unresponsive after progressive mental status changes for 3-4 days. Twelve days prior to this presentation he was diagnosed with a narcotic overdose for which he was maintained in the intensive care unit for respiratory and acute renal failure. He had been prescribed Fentanyl for chronic pain due to metastatic papillary thyroid cancer. He denies alcohol and drug use. He has a history of hypothyroidism, coronary artery disease, and bipolar disorder. He has no significant family history.

RESULTS

MR imaging was performed 10 days after onset of mental status changes. T2-weighted images showed no abnormal signal intensity in the brain. Diffusion-weighted image revealed mild hyperintensity in the periventricular and deep white matter associated with decreased ADC. Follow-up MR imaging was performed 14 days after the onset. T2 and FLAIR images showed high signal intensity throughout the white matter bilaterally consistent with a global leukoencephalopathy. Diffusion-weighted images revealed diffuse hyperintensity of these lesions associated with decreased ADC. The patient had increasing tremor and irregular myoclonus. He continued to deteriorate and died about 20

days later. Autopsy was performed and the diagnosis was confirmed. It showed varying degrees of myelin loss with some spongy change, probably reflecting intramyelinic edema in the deep white matter with relatively spared U-fibers.

CONCLUSION

Diffusion-weighted image showed diffuse hyperintensity with decreased ADC in the deep white matter in delayed postanoxic leukoencephalopathy. Pathologic specimen revealed varying degrees of myelin loss with some spongy change, probably reflecting intramyelinic edema, which causes decreased ADC. We discuss the pathophysiology of this disease.

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KEY WORDS: Diffusion-weighted imaging, postanoxic leukoencephalopathy, pathology

Paper 296 Starting at 4:25 PM, Ending at 4:30 PM

Primary Hyperoxaluria and Calcium Oxalate Deposition: An Unusual Variant of Small Vessel Ischemia

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University of Pennsylvania
Philadelphia, PA

PURPOSE

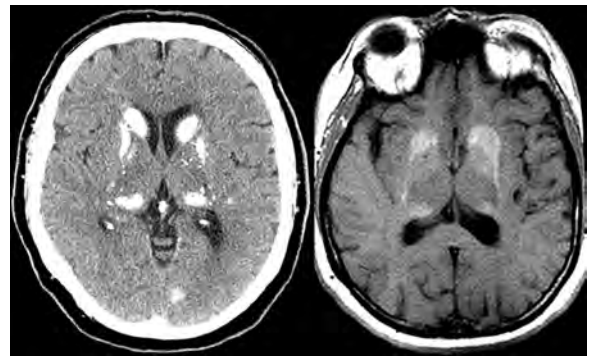
Primary hyperoxaluria is a rare autosomal recessive disorder characterized by excessive synthesis of oxalic acid. Systemic calcium oxalate deposition, or oxalosis, may affect numerous organs, although calcium oxalate deposition in the brain is exceedingly unusual. We describe a case of primary hyperoxaluria and calcium oxalate deposition in the brain presenting as an unusual form of small vessel stroke.

MATERIALS & METHODS

A 58-year-old man with primary hyperoxaluria presented with transient right-sided hemiparesis and hemisensory loss. Diagnostic evaluation included laboratory investigations, echocardiography, and neuroradiologic studies including CT and MR imaging/MR angiography (MRA).

RESULTS

The initial CT revealed extensive hyperdensity scattered throughout the basal ganglia, thalami, perivascular spaces, corona radiata, dentate nuclei, and occipital cortices (Figure 1A). A similar distribution of lesions was evident as hyperintense regions on T1-weighted sequences (Figure 1B). Gradient-echo T2*-weighted sequences revealed corresponding hypointensity. Oxalosis was apparent on imaging studies of the lumbar spine and peripheral vasculature. Echocardiography was unrevealing and MRA demonstrated no evidence of large vessel disease. Antiplatelet therapy was instituted, yet secondary stroke prevention efforts focused on amelioration of progressive calcium oxalate deposition.



CONCLUSION

Oxalosis due to primary hyperoxaluria may lead to crystal deposition in the brain. Calcium oxalate deposition in the perivascular spaces may lead to small vessel ischemia, yet conventional stroke prevention strategies may be of limited efficacy.

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KEY WORDS: Oxalosis, stroke

Thursday Afternoon

3:00 PM - 4:30 PM
Ballroom 6 A

(60b) Interventional: Aneurysms
(Scientific Papers 297 - 307)

See also Parallel Sessions

(60a) Adult Brain: General

(60c) Adult Brain: General and Diffusion Imaging

(60d) Adult Brain: General and 3.0 T

Moderators: John J. Connors, III, MD
John C. Chaloupka, MD

Paper 297 Starting at 3:00 PM, Ending at 3:08 PM**Origin and Effects of Hemodynamic Stresses on the Morphology of Intracranial Aneurysms**

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PURPOSE

To assess the influence of hemodynamic stresses in determining the morphology of cerebral aneurysms using computational fluid dynamics techniques.

MATERIALS & METHODS

Three paraophthalmic internal carotid artery aneurysms were chosen for analysis. One extended along the axis of the parent artery opposite to the direction of flow (aneurysm A) another extended along this axis in the direction of flow (aneurysm B), and the third was symmetrical in relationship to the long axis of the parent artery (aneurysm C). Geometric data derived from 3D DSA studies of the aneurysms were converted to sterolithography (stl) files for transfer to the computational fluid dynamics software code Gambit (Fluent, Inc.). Simulations were performed using Fluent software subject to both steady and unsteady pressure gradient forcing. The Ku pulsatile flow model for the carotid bifurcation was used for unsteady flow; steady flow had the same mean flow rate as the unsteady case. A Newtonian, incompressible flow model was used to represent the blood flow. The arterial walls were assumed to be rigid.

RESULTS

In each instance, the course of the internal carotid artery upstream from the aneurysms was quite different. In aneurysm A this geometry induced significant secondary flows that resulted in very complex fluid motion within the aneurysm throughout the unsteady pulsatile flow cycle. In this aneurysm there was a small pressure gradient on the downstream wall during diastole and this was accompanied by moderate aneurysmal flow. Also, at the time of peak pressure, just before maximum diastolic flow, a strong, reverse pressure gradient developed within the aneurysm. Flow in aneurysm B was much more stable throughout the cardiac cycle with only very small pressure gradients developing within the aneurysm. In both of these aneurysms, wall shear stresses were very small within the aneurysm as compared to those observed near vascular bends and bifurcations.

CONCLUSION

Our simulations showed quite different hemodynamic forces in three paraophthalmic aneurysms of similar size and location but different orientations. As these hemodynamic effects were at least, in part, induced by differences in the geometry of the parent artery upstream from the aneurysms this anatomy may, along with the shape and size of the aneurysm neck, play an important role not only in aneurysm morphology but also in their growth and rupture. The combination of accurate patient specific data regarding aneurysm and parent artery morphology combined with currently available computational fluid dynamic techniques provides a means for

investigating the origin, growth, and possible rupture of intracranial aneurysms that has not been available previously.

KEY WORDS: Aneurysms, fluid dynamics, morphology

Paper 298 Starting at 3:08 PM, Ending at 3:16 PM**Hemodynamic Studies of Coiling in Cerebral Aneurysm by Using Particle Image Velocimetry Method**

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PURPOSE

One of the most popular techniques in endovascular treatments for aneurysms consists of filling the aneurysm with coils. The coils seem to induce the formation of intraaneurysmal thrombosis. Although this technique has shown highly good results for aneurysm treatments, it needs a better understanding of the relevant hemodynamics effects on the thrombosis formation. It is of interest to investigate the relationship of aneurysmal blood flow to thrombosis formation in an experimental set-up. An experimental technique of particle image velocimetry (PIV) for detecting flow pattern in a cerebral aneurysm model was carried out.

MATERIALS & METHODS

The investigations were done using a set of transparent silicone aneurysm models by means of flow visualization. The aneurysm dimensions were respectively 5 mm for the neck diameter and 10 mm for the dome diameter. The parent artery was 3.5 mm in diameter. The fluid properties, composed of water and glycerin were 4 cp for its viscosity and 1g/cm³ for its density. The investigation was carried on at realistic pressures with a minimum of 90 mm Hg for the diastole phase and a maximum of 140 mm Hg for the systole phase. The pulsatile flow, with an average velocity of 220 ml/min was maintained at 37 °C. The flow visualization techniques consisted of reflecting glass particles, an Argon laser, and a CCD camera (25 frames per second) set at the lateral angle view mode. The 3D coils from Micrus Corporation used were the MicroCoil system models made of platinum. In this experiment, a total of 4 3D coils were implemented in the aneurysm. The first two coils were 10 mm in curvature height and 20.3 cm in length. The third and fourth 3D coils were 9 mm in curvature height with a length of 18.4 cm and 8 mm in curvature height with 16.1 cm, respectively.

RESULTS

The flow pattern in the aneurysm was composed of an inflow zone at the distal neck and of an outflow zone at the proximal neck. A rotating vortex was formed at the distal zone of the aneurysm at each systole phase. The vortex circulated along the aneurysm wall rotating on itself. As the vortex traveled, it grew in diameter losing its cohesion. The fluid in the aneurysm was pushed out at the diastole phase and at the beginning of the following systole phase. The vortices were disturbed and diffused as the first coil was induced into the

aneurysm. The incoming flow into the aneurysm and therefore the inside flow were diminished continually with the increasing number of filling coils induced into the aneurysm.

CONCLUSION

The coils covering the neck and the aneurysm wall induce a diffusion in the flow pattern at the aneurysm neck and into the aneurysm. The diffusion and the disappearing flow at the wall may induce the thrombosis. The number of coils seems to be correlated to the effect on reducing the flow patterns. The PIV was useful for analyzing flow pattern in cerebral aneurysm.

KEY WORDS: Coil, PIV, hemodynamics

The authors of this work have indicated the following affiliations/disclosures: Cook-WCE: Research support.

Paper 299 Starting at 3:16 PM, Ending at 3:24 PM

HydroCoil Embolization Results in Progressive Aneurysm Occlusion and a Trend to Postembolization Aneurysm Shrinkage in Large and Giant Canine Bifurcation Aneurysms

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PURPOSE

Previous experiments showed that occlusive stable aneurysm embolization using HydroCoils was achievable with good neointima formation at 3 and 6 months in aneurysms up to 14 mm in size. This current project shows the relationship between packing with HydroCoils and stability of occlusion in large and giant canine bifurcation aneurysms.

MATERIALS & METHODS

Fifteen canines were coiled to maximum occlusion with bare metal framing and HydroCoils. Follow-up angiogram and histologic analysis was performed at 3 or 6 months. Aneurysms were 18-25 mm with dome to neck ratios of < 1.3:1. Angiograms were graded: occluded, residual contrast, dog-ear, or neck remnant.

RESULTS

In the data available, 4 of 5 canines studied at 3 months post-treatment showed progressive occlusion at follow-up with 3 canines progressing to complete aneurysm occlusion and 1 canine progressing to a minimal neck remnant. One of the 5 canines studied at 3 months progressed from a neck remnant to residual aneurysm. Three of 4 canines studied at 6 months posttreatment showed stable complete embolization of the aneurysm and decrease in the overall size of the treated aneurysm: from pretreatment 20 x 15 mm to 17 x 12 mm on follow-up, 18 x 16 mm to 13 x 10 mm on follow-up, and 23 x 23 mm to 17 x 16 mm on follow-up. The 4th 6 month canine showed stable complete occlusion without significant change in aneurysm size. The remaining 3 and 6 month canines are being completed.

CONCLUSION

Use of HydroCoils for embolization allowed for progressive aneurysm occlusion in large and giant canine aneurysms and also was associated with a trend of aneurysm shrinkage in the 6 month posttreatment canines.

KEY WORDS: Aneurysm, embolization, hydrogel

The authors of this work have indicated the following affiliations/disclosures: MicroVention: Consultant, Investor.

Paper 300 Starting at 3:24 PM, Ending at 3:32 PM

HydroCoil for Endovascular Aneurysm Occlusion (The HEAL Registry): An Update

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PURPOSE

Compared to platinum coils, the HydroCoil device achieves higher packing density of cerebral aneurysms. Higher percent packing density may reduce aneurysm recurrence. The HEAL study is a prospective, multicenter registry of patients with cerebral aneurysms treated with HydroCoil.

MATERIALS & METHODS

There are 23 participating sites worldwide and a total of 200 patients to be enrolled. The primary endpoints are: 1) complications/adverse events at treatment time and at 3-6 months and 12-18 months; and 2) recurrence of aneurysm on angiography at 3-6 months and 12-18 months. Additional data collected include degree of aneurysm size, dome-to-neck ratio, rupture status, angiographic occlusion, and aneurysm packing density.

RESULTS

Initial treatment outcome data currently are available for 131 patients. The mean aneurysm packing density of aneurysms treated with HydroCoil is 62%. There were ten (7.5%) thromboembolic events, and one (0.75%) aneurysm perforation. Eight thromboembolic events were treated successfully and did not result in clinical consequences, while three thromboembolic events resulted in ischemic symptoms. There were two deaths from complications of subarachnoid hemorrhage unrelated to the procedure.

CONCLUSION

High packing densities are achieved with HydroCoil therapy, which may lead to a reduced aneurysm recurrence rate. The HEAL registry is currently collecting data regarding recurrence rates. Preliminary analysis of the HEAL registry data indicates that the safety and initial success of HydroCoil therapy of cerebral aneurysms are comparable to results with platinum coils.

KEY WORDS: Aneurysm

The authors of this work have indicated the following affiliations/disclosures: MicroVention: Research grant.

Paper 301 Starting at 3:32 PM, Ending at 3:40 PM**In Vivo Evaluation of the CereStent Intracranial Stent**

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PURPOSE

There is an increasing need for a more flexible intracranial stent than the ones currently available for clinical use. An ideal stent would conform to vascular curvatures yet maintain radial force and provide strut density sufficient for a neck protection role in aneurysm coiling cases. The stent we evaluated (CereStent from the Micrus Corporation) promises to achieve these goals. Our intention was to evaluate the product for efficacy in two animal models, the canine vein pouch model and the rabbit elastase model.

MATERIALS & METHODS

In the canine study 16 aneurysms were created in eight animals using the surgical venous pouch method of sidewall carotid aneurysms. All aneurysms had a dome-to-neck ratio below 1.5. Dense packing of these aneurysms is considered to be very difficult to unachievable without neck protection. All aneurysms were stented with a 30 mm length CereStent and then coiled. One aneurysm was embolized with Micrus platinum coils, the contralateral with competitive coils in each dog. Side selection was randomized prior to coiling. Follow-up angiograms were performed immediately after treatment and 1 month after treatment. Angioscopy was performed in each animal at 1 month. Three- and 6-month data are forthcoming. In a separate study six aneurysms were created in six rabbits using the elastase induction method at the origin of the right carotid artery. The aneurysms were stented and coiled. Angiographic follow-up was performed at 1 month by injecting the central artery of the left ear, obtaining angiogram retrograde fashion. Three- and 6-month data are forthcoming.

RESULTS

All aneurysms were stented and coiled successfully. One dog died several hours after recovery due to rebleeding from the groin. This animal was excluded from the study. In another case, coil migration during implant was observed due to improper oversizing. The stent was retrieved successfully followed by retreatment. Coil protrusion was minimal in 5 cases and nonexistent in 9 cases indicating effectiveness of the stent. Acceptable coil protrusion was observed from the immediate postimplant angiogram in 5 cases. Follow-up demonstrated stent stability. All but one aneurysm demonstrated 100% occlusion with protective intimal coverage at the neck. Extensive neointimal hyperplasia either proximal or distal to the aneurysm neck was observed in three parent arteries, which are in process of further evaluation. In the rabbit study, all stents were deployed successfully and the aneurysms coiled. At 1 month all parent vessels were observed to be patent. Excellent conformance of the stents to the tortuous vessel was observed in all instances. Two aneurysms had neck remnant. There was no sign of intimal hyperplasia or stent migration.

CONCLUSION

Initial studies indicate a highly flexible device with excellent conformability. The stent additionally demonstrated sufficient radial force and coverage to allow tight packing of coils at the aneurysm neck. Angioscopic observations in the canine revealed a high level of stent stability and frequent eradication of the aneurysm neck. Three- and 6-month follow-up studies in both the dog and the rabbit groups are forthcoming.

KEY WORDS: Stent, intracranial, aneurysm

The authors of this work have indicated the following affiliations/disclosures: Micrus Corporation: Research support.

Paper 302 Starting at 3:40 PM, Ending at 3:48 PM**Interventional Aneurysm Therapy of the Pericallosal Artery**

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Essen, GERMANY

PURPOSE

To analyze technical feasibility and efficacy of endovascular occlusion of aneurysms at the pericallosal artery.

MATERIALS & METHODS

Eighteen patients harboring 20 pericallosal aneurysms were considered for endovascular therapy using electrolytically detachable coils (GDC, Boston Scientific; EDC, Dendron-MTI). Aneurysm size was: < 4 mm (n = 12), 4-6 mm (n = 7), > 6 mm (n = 1). Seventeen patients had a SAH, 13 bled from a ruptured pericallosal artery aneurysm, four patients due to an additional aneurysm (MCA n = 3, Pcom n = 1). Patients with SAH were classified as H&H Grade I (n = 5), II (n = 4), III (n = 4), IV (n = 3), and V (n = 1). At the time of treatment four patients had severe vasospasm. Occlusion rate was divided into total (100%), subtotal (95-99%) and incomplete (< 95%) occlusion. Up to the present follow-up angiography, MR angiography and clinical evaluation based on Glasgow outcome scale (GOS) was performed in 17 patients at 6 months.

RESULTS

Embolization with total occlusion was performed in 16/20 aneurysms. Two patients with severe vasospasm could be embolized following administration of papaverine. In 4/20 aneurysms coil embolization was not feasible because of an unfavorable broad-based aneurysm anatomy (n = 2) and severe vasospasm (n = 2). Three of these patients were treated surgically, one (H&H V) died prior surgery. Procedural complication included aneurysm perforation without neurologic deterioration (n = 1). There was no procedure-related death. One day after angiography one patient suffered from a hemiparesis by thromboembolic MCA occlusion, which was thrombolized successfully. CT demonstrated remaining MCA infarction. Ischemic infarction also was visible in two other patients on routine CT. During follow-up two patients with initially total aneurysm occlusion showed subtotal (n = 1) and incomplete (n = 1) aneurysm occlusion, probably due

to recanalization of a partially thrombosed aneurysm compartment. During 6 month follow-up no patient rebled. GOS was: GR (n = 6), MD (n = 4), SD (n = 5), V (n = 1).

CONCLUSION

Endovascular coil embolization of ruptured and unruptured pericallosal aneurysms can be performed effectively and may be a less invasive therapeutic alternative to surgery, especially during the vulnerable vasospasm period. However, comparable to surgery an unfavorable aneurysm anatomy or severe vasospasm may limit endovascular treatment possibilities in this location.

KEY WORDS: Aneurysms, pericallosal artery, embolization

Paper 303 Starting at 3:48 PM, Ending at 3:56 PM

Liquid Embolization of Experimental Wide-Necked Aneurysms with Polyvinyl Alcohol Polymer: A New, Nonadhesive, Iodine-Containing Liquid Embolic Agent

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PURPOSE

The evaluation of polyvinyl alcohol polymer (PVAP), a new, nonadhesive, iodine-containing liquid embolic agent synthesized by the authors for endovascular liquid embolization of experimental wide-necked aneurysms in swine.

MATERIALS & METHODS

Ten broad-based carotid side-wall aneurysms were constructed surgically in 5 pigs. PVAP (40%) in dimethyl sulfoxide (DMSO) was injected over a microcatheter placed inside the aneurysm under temporary balloon occlusion of the parent artery across the neck of the aneurysm. Control angiography was performed immediately after embolization as well as after 4 weeks. Before reangiography multidetector row CT angiography (CTA) was performed and harvested aneurysms were investigated by high-field MR imaging at 3.0 T.

RESULTS

Polyvinyl alcohol polymer can be used at room temperature without prior preparation. Seven aneurysms primarily could be occluded completely (70%), whereas in 2 cases a minimal protrusion of polymerized PVAP into the carotid artery lumen was observed. One aneurysm was embolized almost completely (90%), another aneurysm was partially embolized (~80%) as further embolization was aborted due to a thrombus at the tip of the balloon. During one embolization a leakage of liquid embolic agent from a DMSO-incompatible microcatheter resulted in carotid artery occlusion with no clinical sequelae. Aneurysms embolized with PVAP could well be discriminated from the parent artery in CTA without any beam hardening artifacts. High-field MR imaging

allowed a detailed imaging of liquid embolic distribution within the aneurysm as well as of neo-intima formation. Histologic evaluation confirmed MR findings and revealed only mild foreign-body reaction in 2 embolized aneurysms.

CONCLUSION

Liquid embolization of experimental wide-necked aneurysms with PVAP technically is feasible while handling is facilitated compared to Onyx. The liquid embolic agent is well visible under fluoroscopy due to its high iodine content and enables artifact-free evaluation of treated aneurysms with CT and MR angiography.

KEY WORDS: Wide-necked aneurysms, liquid embolic agent, endovascular

Paper 304 Starting at 3:56 PM, Ending at 4:04 PM

Morphologic Assessment of Middle Cerebral Artery Aneurysms for Endovascular Treatment

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PURPOSE

Large series of endovascular therapy for aneurysms suggest that middle cerebral artery (MCA) aneurysms in the bifurcation region are not as well suited to endovascular therapy as other circle of Willis aneurysms (1, 2). The purpose of our study was to evaluate the incidence of specific morphologic features of middle cerebral artery bifurcation aneurysms which determine suitability for endovascular treatment.

MATERIALS & METHODS

Fifty-eight bifurcation or trifurcation middle cerebral artery (MCA) aneurysms studied angiographically over a 4-year period at our institution were included. Fusiform M1 segment aneurysms, aneurysms involving lenticulostriate branches, or distal M2 segments were excluded. Angiographic images of each aneurysm were reviewed for: size of aneurysm, including maximum, dome diameter, and neck size as well as dome to neck ratio. Angiograms also were analyzed for: branch vessels originating from the aneurysm sac, straightening of the aneurysm wall to suggest intramural thrombus, calcification in the region of the aneurysm, stenosis of the parent vessel, and presence of daughter sacs. Aneurysms then were evaluated subjectively with respect to suitability for endovascular therapy. All post-treatment angiograms that were done were reviewed and classified into four categories: completely occluded, residual filling of sac with > 90% occlusion, and residual filling with < 90% occlusion.

RESULTS

Fifty-eight MCA aneurysms were evaluated in 53 patients. Forty (60%) had not ruptured previously and eighteen (31%) had ruptured. Surgical clipping was performed for 36/58 aneurysms (63%), no treatment as of the time of chart review for 17/58 (30%), endovascular treatment for 3/58 (5%), and surgical wrapping for 1/58 (2%). Fifty-five of 58 patients (95%) were alive at time of discharge. Fifty-one of 58 aneurysms (88%) had a dome to neck ratio less than 2:1.

Mean maximal size was 7.5 mm (range 1.0 to 40.0 mm), mean dome size was 5.7 mm (range 1.0 to 35.0 mm), and mean neck size was 4.9 mm (range 1.0 to 35 mm). Branch vessel incorporation in the aneurysm sac was seen in 23/58 (40%), straightening suggestive of thrombus in 14/58 (24%), calcification in 2/58 (3%), parent vessel stenosis in 1/58 (2%), and daughter sacs in 4/58 (7%). Nine of 58 (16%) aneurysms were judged suitable for endovascular treatment. Twenty-two of 28 treated aneurysms with posttreatment angiograms (78%) had complete occlusion, 2 of 28 (7%) had residual filling of <10% and 4 of 28 (14%) had >10% residual filling.

CONCLUSION

The majority of MCA aneurysms have morphologic features such as a dome to neck ratio less than 2:1 or branch vessel incorporation which may make them unsuitable for endovascular treatment using conventional intraaneurysmal coiling.

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KEY WORDS: Aneurysm, endovascular therapy

Paper 305 Starting at 4:04 PM, Ending at 4:12 PM

Neuroform Stent-Assisted Coiling of Wide Neck Aneurysms: A Single Center Experience

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PURPOSE

To evaluate the angiographic results and clinical outcome of patients treated with stent-assisted coiling using the Neuroform stent.

MATERIALS & METHODS

A retrospective review of patients treated with Neuroform-assisted coiling during the interval between September 2002 and December 2003 was done. Thirty-five aneurysms in 32 patients were treated using this technique. Technical success of the procedure, procedure-related complications, immediate angiographic results and neurologic outcome were recorded. Angiographic results were recorded as occlusion (without neck remnant), subtotal but satisfactory occlusion (> 90% with small neck remnant), residual aneurysm, and failure.

RESULTS

In 34 of the 35 aneurysms stent deployment across the neck of the aneurysm was successful. Proper deployment of the stent could not be achieved in only one aneurysm. Coil embolization was attempted in 31 out of 34 aneurysms where the stent was deployed successfully. Of these, 27 were coiled with preservation of parent artery. Coiling could not be achieved in 4 aneurysms because of vessel rupture in one case and protrusion of coils into the parent artery in remaining three cases. In 10 aneurysms immediate posttreatment angiography showed residual filling; in the remaining 17 there was either total or satisfactory occlusion. Procedure related mortality was 0%. Adverse events occurred in five patients (15%); vessel rupture (n = 2), parent artery occlusion (n = 1), late intraparenchymal hemorrhage (n = 1) and a delayed ischemic stroke in the stented vascular territory (n = 1). Follow-up angiography was available in eight out of 27 treated aneurysms. Aneurysmal regrowth occurred in one patient at 2 months follow-up. No bleeding was recorded during the follow-up period of 2-8 months.

CONCLUSION

Availability of a flexible intravascular stent suitable for use in the intracranial circulation may facilitate endovascular treatment of wide necked intracranial aneurysms. The full value of this technique remains to be determined.

KEY WORDS: Cerebral aneurysm, embolization, stent

The authors of this work have indicated the following affiliations/disclosures: Boston Scientific: Research support/consultant.

Paper 306 Starting at 4:12 PM, Ending at 4:20 PM

Posterior Communicating Artery Aneurysms: Outcomes in Patients Treated with Endovascular Coiling and Surgical Clipping: A Single Center Experience

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PURPOSE

Endovascular therapy for intracranial aneurysms has been available now for over 10 years. Prior studies including the International Subarachnoid Aneurysm Trial (ISAT) published in *Lancet* have evaluated endovascular treatment of intracranial aneurysms in the setting of subarachnoid hemorrhage and have shown it to be a competitive alternative to surgical therapy. Studies by Johnson et al. have supplied data to suggest that endovascular therapy for unruptured aneurysms results in decreased adverse outcomes relative to surgical intervention. To our knowledge no one yet has compared these different treatment modalities specifically involving aneurysms of the posterior communicating artery (Pcom). This investigation was of particular interest to us as surgical outcomes in this patient population are generally better than intracranial aneurysms in other regions. Our objective was to analyze both ruptured and unruptured Pcom aneurysms with regards to new permanent and temporary postprocedure neurologic deficit, procedural related nonneu-

rologic complications, inpatient mortality, length of inpatient hospital stay, residual aneurysm postintervention, and aneurysm regrowth.

MATERIALS & METHODS

Seventy-three patients with 73 posterior communicating artery aneurysms from Loyola University Medical Center undergoing surgical or endovascular treatment during the years 1997-2003 were analyzed retrospectively. Available inpatient and outpatient medical records, imaging studies, imaging reports, and morbidity/mortality annals were reviewed. Only primary Pcom aneurysm interventions were included.

RESULTS

Twenty-three patients were included in the surgical group and 50 patients were included in the endovascular group. Three patients in the surgical group (12%) and seven patients in the endovascular group (14%) demonstrated residual aneurysm on subsequent angiography. Aneurysm regrowth was only encountered in the endovascular group (8 patients, 16%). No patient with regrowth demonstrated new symptoms or subsequent subarachnoid hemorrhage. Regrowth was treated successfully with surgery in three patients and with repeat coiling in three patients (there were no repeat surgical or endovascular interventions in the remaining two patients with stable regrowth). In the surgical group there were a total of 4 (17%) new postprocedural neurologic complications, none were reported in the endovascular group. One nonneurologic complication was reported in the surgical group (4%, CSF leak) compared to 3 (groin arterial access site) complications in the endovascular group (6%). For patients presenting with unruptured aneurysms, average inpatient hospital stay in the endovascular group was 1.6 days compared to 6.0 days for the surgical group. In the endovascular group there were two in-hospital deaths (4%) due to medical complications, none were reported in the surgical group.

CONCLUSION

Our results indicate that for Pcom aneurysms endovascular coiling is an appropriate alternative to surgical clipping. Endovascular patients experienced fewer new postprocedural neurologic complications, and patients within this group presenting with unruptured aneurysms had a decreased postprocedure inpatient hospital stay. Although the percentage of patients with residual aneurysm postintervention was similar between the two groups, patients treated with coiling demonstrated a greater frequency of aneurysm regrowth.

KEY WORDS: Endovascular, aneurysm, Pcom

Paper 307 Starting at 4:20 PM, Ending at 4:28 PM

Prospective Evaluation of CT Angiography to Render a Volume Embolization Ratio in Endovascular Treatment of Intracranial Aneurysms

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PURPOSE

The degree of volume fill with platinum coil embolization likely plays an important role in recanalization. In an effort to reduce the rate of recanalization, maximal embolization of the aneurysm is performed at times beyond angiographic obliteration of the aneurysm. The hydrocoil is an embolic agent that swells with contact of blood. This results in higher volume embolization ratios and, therefore, may reduce recanalization rates.

MATERIALS & METHODS

Ten consecutive patients underwent multislice CT angiography prior to interventional treatment. Using a 3D workstation, hand-drawn regions of interest on 0.625 mm axial slices were used to render a total aneurysm volume. The volume embolization ratio was calculated as a ratio of embolic material volume to total aneurysm volume. Follow-up digital subtraction angiography is performed at 3, 6, and 12 months.

RESULTS

The total volume of aneurysms varied from 0.05 to 4.8 cc. Embolization ratios varied from 23% to 80% (mean 52%). The embolization ratios were significantly different than those calculated using height-width-depth measurements from two-dimensional angiography.

CONCLUSION

The novel use of CTA to determine volume allowed for more precise determination of volume embolization ratios regarding a new embolic material. These ratios may well provide meaningful data regarding recanalization. As the mean embolic ratio was significantly higher than 32% in all but one case, this may portend well for the ability to prevent recanalization using this embolic material. Indeed in all cases that the volume embolization ratio was greater than 40%, stable follow-up digital subtraction angiography is being depicted.

KEY WORDS: Volume embolization ratio, CT angiography, hydrocoil

Thursday Afternoon

3:00 PM - 4:30 PM

Room 606 - 609

**(60c) Adult Brain: General and
Diffusion Imaging
(Scientific Papers 308 - 319)**

See also Parallel Sessions

(60a) Adult Brain: General

(60b) Interventional: Aneurysms

(60d) Adult Brain: General and 3.0 T

Moderators: Danial Hallam, MD

William G. Bradley, Jr., MD, PhD, FACR

Paper 308 Starting at 3:00 PM, Ending at 3:08 PM

Advance Detection of Alzheimer's Disease Using Hippocampal Volumetry

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PURPOSE

To determine in a 3-time point longitudinal study whether the extent and/or rate of hippocampal atrophy during the period of mild cognitive impairment (MCI) predicts future transition from MCI to early-stage Alzheimer's disease (AD).

MATERIALS & METHODS

From an on-going bi-annual longitudinal MR imaging study, we selected normal elderly and MCI subjects that completed 3 examinations and who remained stable over the first two time points. At baseline, 8 normal controls had Global Deterioration Scale (GDS) scores of 1 or 2. The MCI patients (GDS = 3) showed mild memory deficits in the absence of dementia. At the third time point, 8 MCI patients remained unchanged (GDS = 3, nondeclining MCI) and 9 MCI patients progressed to mild AD (GDS = 4, declining MCI). At baseline and both follow-ups, all subjects received full diagnostic work-up including medical, neurologic, psychiatric, neuropsychologic evaluations and MR imaging of the brain. In addition to standard diagnostic sequences, research sequence was obtained (1.2 mm thick sagittal T1-weighted sections). The scans from baseline, follow-up 1, and follow-up 2 were coregistered and reformatted to a standard coronal plane with a 1.5 mm slice thickness. For each subject volumes of the left hippocampus and supratentorial compartment (estimate of the head size) were measured by

using previously described and validated methods. Statistical analyses were performed using ANCOVA and logistic regression models controlling for head size.

RESULTS

At all 3 time points, the hippocampal volume differed ($p < .05$) among normal controls, nondeclining MCI and declining MCI. At baseline, as compared to the normal control group, the average hippocampal volume of the nondeclining MCI group was less by 10% and that of the declining MCI group was less by 21%. At the first follow-up, they were less by 8% and 24%, respectively and at the second follow-up, by 13% and 24%, respectively. At baseline (4 years prior to progression to AD) the hippocampal volume predicted declining MCI from nondeclining MCI patients with overall accuracy of 71%. Over the 4 years, the rate of the hippocampal atrophy was 1.1%/year in the normal control group, 3.0%/year in nondeclining MCI, and 3.4%/year in declining MCI group. Over the 4 years, the rate of the hippocampal atrophy in the declining MCI group was significantly different than that in the control group (sensitivity 78%, specificity 75%, $p < .05$).

CONCLUSION

At cross section, all groups (controls, nondeclining MCI, declining MCI) are distinguished statistically from each other at each of the 3 time points. Longitudinally, the declining MCI are different from controls but similar to nondeclining MCI. In summary, the significant cross-sectional differences along with equivalent rates of progressive hippocampal atrophy in nondeclining and declining MCI patients suggests that MCI represents a preclinical stage of AD with conversion dependent on the magnitude of atrophic change. This study and other clinical and pathologic observations suggest that it is only the matter of time before most amnesic MCI patients will show the clinical AD symptomatology. The hippocampal volume accurately predicts MCI patients who decline to AD 4 years prior to clinical diagnosis.

KEY WORDS: Hippocampus, MCI, longitudinal

Paper 309 Starting at 3:08 PM, Ending at 3:16 PM

Diffusion Tensor MR Imaging of the Brain in HIV-Positive Patients

Thurnher, M. M.¹ • Stadler, A.¹ • Eisenhuber, E.¹ • Rieger, A.¹ • Schmied, B.² • Maly-Sundgren, P.³

¹University Hospital Vienna, Vienna, AUSTRIA, ²Hospital Otto-Wagner-Spital, Vienna, AUSTRIA, ³University of Michigan, Ann Arbor, MI

PURPOSE

Although MR imaging is the most sensitive imaging modality for depicting the effects of HIV in the brain, it is nevertheless not sensitive enough to show early pathologic involvement. The data from recent studies suggest that diffusion tensor imaging (DTI) potentially could be more sensitive in detecting early CNS involvement by HIV than MR imaging. Recently, pathologic studies have shown that hippocampal injury is common in HIV encephalitis, and may play a role in this disorder. The goal of this prospective study was to determine whether diffusion tensor MR imaging; (a) can detect early abnormalities in the brain especially in hip-

pocampus in HIV-positive patients, (2) if there is a correlation between the DTI abnormalities and severity of the disease.

MATERIALS & METHODS

MR imaging, and DTI were performed in 60 HIV-positive patients and 30 control subjects on a 1.5 T clinical scanner. Fractional anisotropy (FA) and apparent diffusion coefficient (ADC) maps were generated from the DTI data set and coregistered with T2-weighted MR images. Uniform regions of interest (ROIs) were positioned on the images in following regions of the brain: 1) splenium of the corpus callosum; 2) genu of the corpus callosum, 3) frontal white matter, and 4) hippocampus. HIV-positive patients were subdivided into 2 groups according to the CD4 count; a) under 250 cells/mm³, and b) higher than 250 cells/mm³. According to the viral load level in plasma, three groups of patients were made; a) < 50 copies/mL, b) 50-100000 copies/mL, and c) > 100000 copies/mL. The clinical, immunologic, and virologic characteristics were determined, and compared with neuroradiologic findings.

RESULTS

Fractional anisotropy was reduced in genu of the corpus callosum, frontal white matter, and hippocampus in HIV-positive patients compared to the controls but did not reach the statistical significance. Apparent diffusion coefficient was increased significantly in genu of the corpus callosum compared to the controls, and increased in other locations without statistical significance. Higher ADC values in frontal white matter and splenium of the corpus callosum correlated well with increase of viral load; patients with viral load higher than 100000 copies/mL had the highest ADC values. No statistical significance was found in FA and ADC values in all measured brain regions between patients and controls related to the CD4 count. No correlation was found between therapy naive and patients who were on HAART and DTI measurements.

CONCLUSION

The results of our study suggest that DTI may be much more sensitive to the disintegration of neuronal structure in HIV-related brain disease than conventional MR imaging. According to the results from the neuropathologic studies where vulnerability of hippocampal neurons and myelins in the frontal region in HIV was found, reduced anisotropy in those brain regions was expected. However statistical significance threshold was not found. Knowing the fact that CD4 count and viral load levels are not anymore reliable markers for HIV infection, new markers are necessary, especially for following these patients during the antiretroviral therapy, DTI has a potential to develop into a powerful technique for the study of brain structure in HIV-positive patients.

KEY WORDS: Human immunodeficiency virus (HIV), diffusion tensor imaging, MR imaging

Paper 310 Starting at 3:16 PM, Ending at 3:24 PM

Circulatory Changes in Cerebral Perfusion Resulting from HIV-Associated Dementia

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University of North Carolina at Chapel Hill
Chapel Hill, NC

PURPOSE

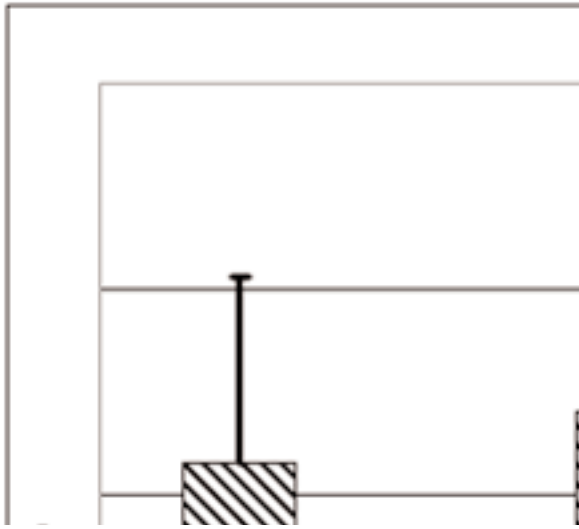
To explore the role of circulatory pathology in HIV-associated dementia, using an atlas-based statistical comparison of hemodynamic changes across HIV subjects with advancing levels of cognitive dysfunction.

MATERIALS & METHODS

MR perfusion images were gathered from 25 HIV subjects who were clinically stratified into one of three cognitive classifications: normal cognitive function, minor cognitive motor disorder (MCMD), or HIV-associated dementia (HAD). Perfusion images were obtained at 3 T using a gradient-echo echo-planar sequence with TR of 2.0 sec, TE of 54 msec, with FA of 60 degrees, 128 x 128 matrix and 230 mm FOV repeated 40 times. A single dose of Gd-DTPA contrast agent was injected rapidly intravenously at the end of the 5th scan and flushed with saline. Data was processed off-line in the manner described by Ostergaard and Weisskoff to create images of cerebral blood flow (CBF) and cerebral blood volume (CBV). All scans within each cognitive group were summed to form an atlas with expected mean and variance for both CBF and CBV measures. Mean scans of MCMD and HAD groups were compared to those of the HIV normal cognitive group using an image-based z-score analysis technique to identify regions of significant deviation. Regional analysis then was completed to quantify the average circulatory changes between the groups with regions selected in the central white matter of the left hemisphere, and the deep gray matter nuclei.

RESULTS

Using atlas-based comparison, contrary to prior reports (1), we found areas of increased CBF and CBV in the white matter of the MCMD and HAD groups as compared to the HIV group of normal cognition. There was no significant change in gray matter of the cortex or deep nuclei except for a small area of increased CBV in the left caudate. Group comparison of the white matter of the centrum semiovale confirms an average increase in CBF and CBV of the white matter in MCMD and HAD subjects. The region of interest analysis of the deep gray matter nuclei showed no significant differences between groups.



CONCLUSION

Our results indicated localized circulatory changes in the white matter with increased CBF and CBV in patients with MCMD and HAD. There were no statistically significant changes in gray matter. The atlas-based comparison identified a general trend in cerebral perfusion showing elevation in CBF and CBV measurements for individuals of increasing cognitive dysfunction. Progressive increases in CBV through the entire white matter region of the centrum semi-ovale, imply an association between advanced white matter disease (atrophy and/or demyelination) and circulatory alterations.

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KEY WORDS: Dementia, HIV, cerebral blood flow

Paper 311 Starting at 3:24 PM, Ending at 3:32 PM

Analysis of the Utility of Diffusion-Weighted MR Imaging in Distinguishing Central Nervous System Toxoplasmosis from Lymphoma

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PURPOSE

Toxoplasmosis and lymphoma are common lesions of the central nervous system in patients with acquired immune deficiency syndrome (AIDS). It is often difficult to distinguish between these lesions clinically and radiographically. Because the treatment of these lesions differs significantly, it is an important distinction to make, as the implementation of incorrect therapeutic measures may result in substantial morbidity and mortality. Previous research has demonstrated restricted diffusion within lymphomatous lesions and bacterial abscesses in the brain (1). However, little work has been done to evaluate the diffusion characteristics of toxoplasmosis. In a study of 21 patients performed by Camacho, et al. in

April 2003 (2), no toxoplasma lesion was found to have an ADC ratio below 1.0, and no lymphoma lesion was found to have an ADC ratio above 1.6, indicating that ADC ratios may be helpful in making the distinction. However, preliminary work at our institutions has revealed that there may be a wider and less characteristic spectrum of ADC values in toxoplasmosis lesions than previously thought, so this study was designed to explore further the utility of diffusion-weighted imaging and ADC maps/values in making the distinction between toxoplasmosis and lymphoma.

MATERIALS & METHODS

The MR studies of 21 AIDS patients with untreated CNS toxoplasmosis at 2 institutions were reviewed retrospectively. A total of 39 lesions were included. The signal characteristics of these lesions on diffusion-weighted images and ADC maps were evaluated. The ADC ratios of the lesions were calculated (defined as the ratio of an ADC value obtained within the lesion to the ADC value of a region of interest (ROI) in the contralateral normal white matter.) To date, 5 lesions in 2 patients with lymphoma also have been analyzed.

RESULTS

Multiple patterns of diffusion were demonstrated in toxoplasma lesions: restricted diffusion, increased diffusibility, normal diffusion, T2 shine-through, and mixed and indeterminate patterns. The ADC ratios calculated are listed in Table 1. The 17 toxoplasma lesions with values > 1.6 were found in 7 patients, 3 of whom had additional toxoplasma lesions with lower ADC ratios in the 1.0-1.6 range.

Table 1: Results

ADC ratio	Number of toxoplasma lesions	Number of lymphoma lesions
<1.0	1	0
1.0-1.6	21	5
>1.6	17	0
Total number of lesions: 39 (Range of ADC ratios 0.8-2.8)		Total number of lesions: 5 (Range of ADC ratios 1.0-1.5)

CONCLUSION

Toxoplasmosis exhibits a wide spectrum of diffusion characteristics with ADC values ranging from 0.8 to 2.8, which have significant overlap with those of lymphoma. Therefore, in the majority of cases, diffusion properties cannot be reliably used to distinguish between toxoplasmosis and lymphoma.

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KEY WORDS: Diffusion, toxoplasmosis, lymphoma

Paper 312 Starting at 3:32 PM, Ending at 3:40 PM**Utility of Diffusion-Weighted Imaging over Conventional MR Imaging in Complicated Course of Bacterial Meningitis**

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PURPOSE

The purpose of this study was to evaluate the utility of diffusion-weighted imaging (DWI) in comparison to conventional MR imaging in complicated cases of bacterial meningitis.

MATERIALS & METHODS

We reviewed DWI and MR findings in 11 patients with a complicated course of bacterial meningitis. The patients were 6 males and 5 females, ages ranging from 7 days to 81 years. There were 6 patients with different degrees of brain infarction due to vasculitis. Four patients had purulent leptomeningitis. One patient had subdural empyema and periorbital abscess. Diffusion-weighted imaging and the apparent diffusion coefficient (ADC) maps ($b = 0, 1000 \text{ sec/mm}^2$, 3 orthogonal orientations) were obtained. T1- and T2-weighted, gadolinium-enhanced T1-weighted, and fluid attenuated inversion recovery images (FLAIR) and MR angiography (MRA) also were obtained.

RESULTS

In 3 of 6 patients with brain infarction, DWI showed hyperintensity with decreased ADC, characteristic finding of acute infarction in the bilateral fronto-parietal or parieto-occipital cortices due to vasculitis. In neonatal brain, there was a clear advantage of DWI over T2-weighted images due to increase water content. In other 3 patients, acute infarction was detected on DWI to a better extent compared to T2-weighted images in bilateral basal ganglia, the deep white matter or the corpus callosum. These infarctions were related to vasculitis of small to large arteries, which were seen on MRA. In 4 patients, DWI showed purulent meningitis as hyperintensity with decreased ADC compared with CSF. Although FLAIR images demonstrated the findings to a good extent, DWI were clearly superior to show the abnormalities. In 1 patient, DWI showed periorbital abscess and subdural empyema as hyperintensity with decreased ADC. One patient with Lemierre's syndrome shows right jugular vein thrombosis, right sigmoid sinus thrombosis, cavernous sinus thrombophlebitis, and abscess formation in the cavernous sinus with severe narrowing of the right internal carotid artery and watershed infarction. Only DWI could detect the abscess formation in the cavernous sinus.

CONCLUSION

Diffusion-weighted imaging are useful in characterizing complications of meningitis such as cerebral infarction, purulent leptomeningitis, subdural empyema, cavernous sinus abscess formation. Although many of these complications were recognized with conventional MR imaging, DWI increased the conspicuity of these findings being particularly important in the pediatric brain for vascular insults, purulent leptomeningitis, and cavernous sinus abscess.

KEY WORDS: Meningitis, diffusion-weighted imaging, complications

Paper 313 Starting at 3:40 PM, Ending at 3:48 PM**Doppler vs MR Flowmetry in Atherosclerotic Carotid Artery Disease**

Özsarlak, Ö. • Geniets, C. • Van Goethem, J. W. • Maes, M. • Parizel, P. M.

University Hospital Antwerp
Edegem (Antwerp), BELGIUM

PURPOSE

The aim of this study is to compare the flow characteristics of carotid arteries using MR and Doppler flowmetry.

MATERIALS & METHODS

Twenty healthy subjects and 20 patients with a carotid artery stenosis underwent both MR and Doppler examinations for assessment of the degree of stenosis. Three-dimensional phase-contrast MR flowmetry is obtained using retrospective cardiac-gating with a VENC factor of 200 cm/s. Peak systolic velocity, peak diastolic velocity, RI values, ICA/CCA index for both systolic and diastolic peak values, and curve changes were compared with those obtained on Doppler imaging.

RESULTS

Although, the peak systolic and diastolic velocity values were significantly different, RI, ICA/CCA index, and the curve profiles were comparable on both modalities in healthy subjects, and the patients with a stenosis ($p < 0.001$ for both RI and ICA/CCA index). These results are showing that MR flowmetry is competitive to the carotid Doppler examination for assessing the carotid artery stenosis.

CONCLUSION

The phase contrast MR flowmetry allows a hemodynamic assessment of the carotid arteries with comparable findings obtained on Doppler imaging.

KEY WORDS: MR flowmetry, carotid, stenosis

Paper 314 Starting at 3:48 PM, Ending at 3:56 PM**Interobserver Variability of CT Perfusion**

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¹University of Miami, Miami, FL, ²University of Michigan, Ann Arbor, MI

PURPOSE

To assess the interobserver reproducibility for the calculation of CT perfusion parameters including cerebral blood volume (CBV), cerebral blood flow (CBF), and mean transit time (MTT).

MATERIALS & METHODS

Four independent observers (2 neuroradiology fellows and 2 attending neuroradiologists) performed CT perfusion analysis using perfusion 2 software (GE Medical Systems, Milwaukee, WI) on 10 patients at 2 different slice levels. Three observers were blinded to patient diagnosis. The observers selected input artery, input vein and selected region of interest independently. All selected the anterior cerebral artery as input artery. One attending neuroradiolo-

gist has calculated independently over 100 CT perfusion cases, the other 3 observers were given a 45-minute instruction by the experienced neuroradiologist. Multivariate regression analysis for the calculation of fraction of variance in observer for MTT, CBF, and CBV, correlation of patient, affected side and vascular territory (anterior cerebral artery, middle cerebral artery, and posterior cerebral artery) was performed. P value of < 0.05 was significant.

RESULTS

The interobserver fraction of variance (Rho) for MTT, CBF, and CBV was 0.04, 0.001, and 0.02 respectively. Correlation for affected side and arterial territory for MTT was (Rho) 0 and 0; CBF - 0.03 and 0.08; CBV - 0.1 and 0 respectively.

CONCLUSION

There is good correlation between observers measuring MTT, CBF, and CBV. CT perfusion calculations can be mastered in a relatively short time, if performance criteria are adhered to strictly. We advocate that CTP analysis be taught and performed by radiology technicians.

KEY WORDS: CT perfusion, interobserver variability

Paper 315 Starting at 3:56 PM, Ending at 4:04 PM

Evaluation of Sinus Vein Thrombosis by Contrast-Enhanced MR Venography

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PURPOSE

Slow and alternating flow as well as anatomical variants may mimic sinus vein thrombosis (SVT) using conventional 2D time-of-flight MR venography. We defined a contrast-enhanced (CE) MR venography (MRV) acquisition protocol and report preliminary results of an ongoing study in SVT patients.

MATERIALS & METHODS

In nine patients (7 female, 2 male, mean age 32.6 years), clinically suspected of suffering from SVT, ten CE FLASH 3D GE MRV studies were performed using a care bolus technique (TR 5.28, TE 1.91, FOV 250, TA 3:22) and power injection (2 ml/s) of gadolinium (0.2 mmol/kg). In 7/10 CE MRA studies the findings were compared to 2D time-of-flight MR venography (TOF MRV) and/or multislice CT venography (CTV).

RESULTS

In 4 studies (3 patients) SVT was diagnosed and in six patients SVT could be ruled out on the basis of CE MRV without requiring additional imaging procedures. The findings of multislice CTV, preceding CE MRV due to logistic reasons in three patients, agreed well with CE MRV. Contrast-enhanced MRV provided detailed anatomical information with respect to the dural sinus, bridging veins, and internal cerebral veins superior to TOF MRV and equivalent to CTV, without requiring bone segmentation techniques like CTV.

CONCLUSION

Our preliminary results indicate that the applied CE MRV sequence might be appropriate for the assessment of SVT patients without using ionizing radiation. It combines superior spatial resolution as compared to TOF MRV with shorter acquisition times as compared to TOF MRV and previous published CE MRV techniques.

KEY WORDS: Sinus vein thrombosis, MR imaging, venography

Paper 316 Starting at 4:04 PM, Ending at 4:12 PM

MR Digital Subtraction Angiography in Patients with Cerebral Arteriovenous Malformations

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¹German Cancer Research Center, Heidelberg, GERMANY,

²University of Heidelberg, Heidelberg, GERMANY

PURPOSE

The purpose of this study was to evaluate the usefulness of a new ultrashort contrast-enhanced (CE) MR angiography (MRA) for the morphologic evaluation of cerebral arteriovenous malformations (AVMs).

MATERIALS & METHODS

Twenty-five patients with angiographically confirmed cerebral AVMs were included into the protocol. For ultrashort CE MRA a 3D spoiled gradient-echo sequence with a TR/TE = 5/2 ms flip angle of 50° and a matrix size of 128 x 256 was performed with an acquisition time of 9 sec. The CE MRA was performed after bolus application of 0.1 mmol/kg BW of Gd-BOPTA (MultiHance®). The method was compared with conventional X-ray DSA and time-of-flight (TOF) MRA to assess the angioarchitecture of the malformations which is essential for treatment planning and follow-up. The patient studies were evaluated in a double blind reading. Two experienced MR imaging readers independently evaluated both techniques with regard to the assessment of feeding arteries, AVM nidus and venous drainage patterns. For quantitative evaluation, which was performed from the digital source images, vessel to background contrast and contrast-to-noise ratios were calculated. CE MRA was able to detect all AVMs seen on DSA, while the TOF MRA failed in one patient with a very small AVM. In the assessment of the different vessel components of the AVM there was no difference for the detection and delineation of feeding arteries and the AVM. The venous drainage patterns always could be delineated clearly in the CE MRA whereas TOF MRA could demonstrate the exact venous drainage in only 9 patients.

RESULTS

In the quantitative analysis both the vessel to background contrast and contrast-to-noise was significantly ($p < .001$; unpaired t-test) better for the CE MRA for all vascular components. CE MRA with Gd-BOPTA was found to be superior to conventional TOF MRA in the assessment of the angioarchitecture of cerebral AVMs especially regarding the assessment of the venous drainage patterns. The superiority is supported by the improved vessel-to-background contrast and contrast-to-noise ratios.

CONCLUSION

The major limitations of this new technique consist of a low spatial resolution at the used time resolution which can be improved by further sequence modifications. CE MRA is thus an important additional imaging technique for treatment planning and follow-up of AVMs.

KEY WORDS: Arteriovenous malformations, MR DSA, contrast media

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of MultiHance® made by Bracco for cerebral MRA.

Paper 317 Starting at 4:12 PM, Ending at 4:20 PM

MR Imaging of Pyogenic Ventriculitis: Difference between Imaging Techniques

Tsuchiya, K. • Honya, K. • Fujikawa, A.

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Tokyo, JAPAN

PURPOSE

Pyogenic ventriculitis usually develops secondary to meningitis or cerebral abscess. As it may be lethal due to complications such as hydrocephalus, the diagnosis should be established promptly and precisely. Our purpose was to report MR imaging features of ventriculitis comparing those on different MR imaging techniques including postcontrast T1-weighted imaging, FLAIR imaging, and diffusion-weighted (DW) imaging.

MATERIALS & METHODS

We reviewed MR images from seven patients (four men and two women aged 0 to 75 years) with clinically diagnosed ventriculitis. All of them had meningitis diagnosed on the basis of CSF findings. MR examinations at 1.5 T included T2-weighted spin-echo, FLAIR, pre and postcontrast T1-weighted spin-echo imaging as well as single-shot echoplanar DW imaging.

RESULTS

All patients showed both ependymal enhancement on postcontrast T1-weighted images and hyperintensity within the trigone of the lateral ventricle on diffusion-weighted images. The extent of the ependymal enhancement exceeded that of the hyperintensity on DW images in four patients, while the hyperintensity on DW images was larger than or equal to the ependymal enhancement in three patients. Although the hyperintensity on DW images possibly representing intraventricular pus was an outstanding finding, corresponding hyperintensity also was demonstrated on FLAIR images in six of the seven patients. Other abnormalities included hydrocephalus (six patients), abnormal meningeal enhancement (five patients), subdural empyema (two patients), and brain abscess (one patient).

CONCLUSION

The diagnosis of ventriculitis is made most reliably when the abnormal ependymal enhancement is present on postcontrast T1-weighted images. However, hyperintensity that is found on FLAIR and DW images also can be a suggestive finding of ventriculitis before contrast administration.

KEY WORDS: MR imaging, ventriculitis, diffusion-weighted imaging

Paper 318 Starting at 4:20 PM, Ending at 4:25 PM

Posterior Cerebral Artery Occlusion as a Result of Racemose Neurocysticercosis

Perez, C. L. • Chason, D. P. • Mendelsohn, D. B.

University of Texas Southwestern Medical Center
Dallas, TX

PURPOSE

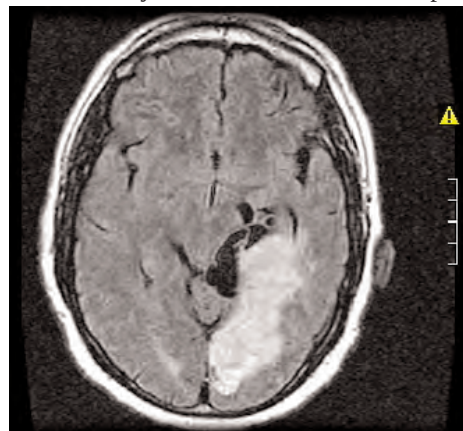
To report a case of subarachnoid racemose neurocysticercosis complicated by PCA territory infarct.

MATERIALS & METHODS

Case report with clinical and radiologic observations.

RESULTS

A 47-year-old Hispanic male presented to the ER with 3 days of frontal headache, followed by sudden onset of blurry vision. The patient had emigrated recently to the United States from Mexico, and his past medical history was remarkable for a single episode of seizure 12 years prior, which was untreated. Physical exam revealed right homonymous hemianopsia. Nonenhanced head CT demonstrated a large low-density area involving the left parasagittal occipital lobe, and a large cyst in the left ambient cistern. MR of the brain exhibited a minimally enhancing, multiloculated, cystic mass in the left ambient cistern with mass effect on the midbrain and pons. Diffusion-weighted imaging demonstrated restricted diffusion in the medial left occipital lobe, consistent with an acute left PCA territory infarct. Repeat MR imaging/MRA 3 days later showed an evolving subacute infarct, and an occluded left PCA. Studies for CSF and serum cysticercus antibodies were positive.



CONCLUSION

Neurocysticercosis is the most common parasitic disease involving the nervous system. Although endemic in Latin America, China, India, and sub-Saharan Africa, cysticercosis is becoming increasingly prevalent in the United States because of continued immigration. Cerebral infarction induced by neurocysticercosis is an uncommon, yet accepted complication. In the appropriate clinical setting, neurocysticercosis should be included in the differential diagnosis as a potential cause of stroke.

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KEY WORDS: Neurocysticercosis, stroke

Paper 319 Starting at 4:25 PM, Ending at 4:30 PM

MR Features of Cerebral Aspergillosis in an Immunocompetent Patient: Correlation with Histology and Elemental Analysis

Phuttharak, W. • Hesselink, J. • Wixom, C.

University of California San Diego Medical Center
San Diego, CA

PURPOSE

To present an unusual case of cerebral aspergillosis in an immunocompetent patient and correlate the MR appearance with pathology and laboratory data.

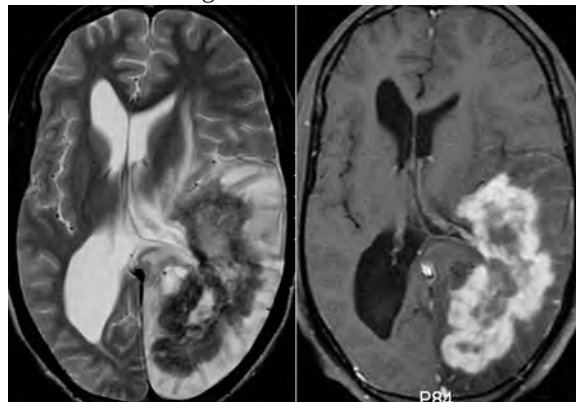
MATERIALS & METHODS

A 24-year-old African man from Sudan presented with severe headaches, worse on the left side. He was diagnosed with pulmonary tuberculosis 10 months earlier, which was incompletely treated. He had no history of any systemic underlying disease or immunosuppressive therapy. Serology for HIV was negative. MR imaging was performed.

RESULTS

The mass had a complex appearance on MR imaging. T2-weighted images revealed a thick hypointense perimeter and a heterogeneous hyperintense core. Margins of the lesion were well-defined but irregular. On T1-weighted images the mass was heterogeneous but mostly mildly hypointense. A thick enhancing rim with a central nonenhancing portion was seen on postcontrast T1-weighted scans. The T2 hypointense zone was thicker than the enhancing rim, which correlated with a very dark 2 mm band on the T2-weighted images along the inner margin of the enhancement. Peri-lesional vasogenic edema and evidence of brain herniation also were depicted. The patient had a craniotomy and excisional biopsy 5 days after admission. A hardened mass was found, without areas of gross hemorrhage. No fluid or pus could be aspirated from the central cavity. Microscopic specimens showed a well formed granuloma with central areas of

necrosis. The periodic acid-shiff (PAS) and Grocott methanamin silver stain (GMS) revealed many septate fungal hyphae. There was no evidence of calcium or hemosiderin between the well formed granuloma and the necrotic center. However, prominent iron deposits were noted on Perl's stain for iron. Elemental analysis by inductively coupled plasma atomic emission spectrometry (ICP-AES) confirmed increased iron. Other intrinsic mineral elements such as magnesium, zinc, and calcium were also found. Culture from brain biopsy material showed *Aspergillus flavus*. The patient received long term antifungal drug therapy and improved clinically. The patient has survived more than 2 years since initial diagnosis.



CONCLUSION

Cerebral aspergillosis is rare in immunocompetent patients. A huge mass as demonstrated in this case also is uncommon and makes differentiation from malignant tumor more difficult. The wall of a fungal lesion is thicker and more pronounced in a host with an intact immune system. The low signal zone along the inner wall of this mass on T2-weighted images is a characteristic feature of fungal infection. This low signal zone had been attributed to hemorrhage or dense aspergillus hyphae. Recently, this finding has been related to iron accumulation, which is known to be essential for the growth of fungi. Other paramagnetic elements such as magnesium, zinc, and calcium as found in our elemental analysis are also probable components.

KEY WORDS: Aspergillosis, cerebral infection, MR imaging

Thursday Afternoon

3:00 PM - 4:30 PM

Room 611 - 612

**(60d) Adult Brain: General and 3.0 T
(Scientific Papers 320 - 330)**

See also Parallel Sessions

(60a) Adult Brain: General

(60b) Interventional: Aneurysms

(60c) Adult Brain: General and Diffusion Imaging

Moderator: Norman J. Beauchamp, Jr., MD, MHS
Suresh C. Patel, MD

Paper 320 Starting at 3:00 PM, Ending at 3:08 PM

3 T MR Evaluation of Brain Tumors with Spectroscopy and Arterial Spin Labeling Perfusion Studies

Appignani, B. • Alsop, D. • Hackney, D. B. • Lenkinski, R. • Wong, E. T. • Wu, J.

Beth Israel Deaconess Medical Center
Boston, MA

PURPOSE

These studies investigate whether perfusion measurements obtained by arterial spin labeling (ASL), and interpreted in combination with metabolic data from 3 T MR spectroscopy (MRS), provide useful diagnostic information about the viability and extent of brain tumors. The ASL technique permits an actual measurement of blood flow in and around tumors. In contrast, susceptibility imaging techniques yield measurements of relative cerebral volume complicated by the effects of varying vascular permeability and disruption of the blood-brain barrier in brain tumors. Assessment of brain tumor perfusion has clinical value because brain tumor vascularity is an indicator of tumor grade, and appears to be related to tumor proliferation and metabolic activity (1-5). Spectral abnormalities in MRS correlate with tumor grade (6) and reveal the presence of tumor infiltration beyond enhancing margins (7). The combination of perfusion and MRS data may provide information about the effectiveness of brain tumor treatment and the development of recurrence or progression.

MATERIALS & METHODS

Arterial spin labeling and MRS data were obtained on 12 patients with gliomas and 2 with metastases. All but one patient had had surgery and radiation therapy, and some had been given chemotherapy. Single and multivoxel MRS was performed. Evaluation was based on the relative amounts of choline (Cho), creatine (Cr), N-acetyl-aspartate (NAA), lipid/lactate, and myo-inositol in the spectra and on measurements of Cho/Cre ratios. Arterial spin labeling was per-

formed using background suppressed continuous arterial spin labeling with a stack of variable density spiral readout. Areas of MRS abnormality were compared to ASL and other images.

RESULTS

Arterial spin labeling of glioblastomas (n = 6), revealed increased perfusion, relative to gray matter, in most tumor treatment sites, generally in regions of enhancement and matched with areas of elevated choline. Some radiation-treated regions with both choline and lipid/lactate elevations were hypoperfused. In intermediate grade tumor treatment sites mildly increased choline and mild perfusion increases or decreases were identified in stable tumors, but hyperperfusion and high levels of choline were found in growing tumors. One patient with an untreated oligodendroglioma had modestly increased choline and decreased NAA, but hyperperfusion on ASL. A low-grade brain stem glioma which shrunk after therapy demonstrated hypoperfusion. Both metastases, suspicious for recurrence on MRS, had only mild increases in perfusion on ASL.

CONCLUSION

Arterial spin labeling in combination with MRS added metabolic information to the assessment of brain tumors. Arterial spin labeling may help to map areas of tumor which are active and those which have responded to treatment. Important advantages of the ASL method are that it is rapid, requires no contrast injection and, with appropriate imaging sequences, it can be free from susceptibility artifacts often found in surgical sites and associated with tumor hemorrhage.

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KEY WORDS: Brain tumor, arterial spin labeling, spectroscopy

Paper 321 Starting at 3:08 PM, Ending at 3:16 PM

T1-Weighted Imaging of the Brain at 3 T: Sequence Options and Optimization

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Michigan State University
East Lansing, MI

PURPOSE

To demonstrate the advantages and challenges of T1-weighted brain imaging at 3 T with emphasis on sequence options and optimization for whole brain clinical imaging.

MATERIALS & METHODS

Axial two-dimensional (2D) spin-echo (SE), fast spin-echo (FSE), T1-FLAIR, and 3D fast spoiled-gradient recalled (FSPGR) T1-weighted sequences were evaluated during

clinical protocol development on a 3 T whole body scanner (GE Medical Systems, Waukesha, Wisconsin) using a quadrature head coil. Contrast features were assessed with respect to gray-white differentiation and uniformity. The impact of dielectric effect, susceptibility, and chemical shift artifacts, crosstalk, contrast enhancement, sequence imaging time, and signal-to-noise ratio (SNR) were compared. The effects of receiver bandwidth (RBW), echo train length (ETL), and choice of flip angle (FA) and TR and TE on image quality and artifacts also were evaluated. Practical scan parameters for whole brain clinical imaging at 3 T are suggested.

RESULTS

Greatest differentiation of gray and white matter was achieved with T1 FLAIR and FSPGR. Inherent magnetization transfer effects in the FSE sequence result in less intrinsic image contrast but improve conspicuity of contrast enhancement. T1 FLAIR occasionally does not show lesion enhancement. Two-dimensional acquisitions showed greater SNR with interleaved acquisitions compared to contiguous slice profiles presumptively because of cross-talk between adjacent slices. T1 FSE sequences were compromised by blurring with increasing ETL beyond 4 but the T1 FLAIR sequences tolerated ETL of 8 without degradation. Susceptibility was greatest about the posterior paranasal sinuses. Susceptibility artifact was lessened by using a higher ETL for FSE, and increasing RBW to 31.25 kHz for all the sequences. The increased RBW partially negates the SNR benefits of the higher field strength and the image quality was better with RBW of 15.6 kHz. Chemical shift misregistration artifacts were minimal at 15.6 kHz. Dielectric effect was most conspicuous with SE and least with the FSPGR sequence but did not interfere with expected contrast features on any scan. Flow-related artifacts were greater with the spin-echo sequences. Relative signal-to-noise was greatest for the FSE, followed by the T1-FLAIR, SE, and FSPGR, respectively.

Sequence	TR	TE	ETL/TL/IR PREP	FA	NEX	Matrix	Slice Thk	Slice Gap	SNR	Scan Time
SE	450	19	—	RF2 180	2	320 x 192	5 mm	Interleave33		4:26
FSE	667	16	ETL 2	RF2 160	2	320 x 192	5 mm	Interleave46		3:18
T1 FLAIR	2400	16	ETL 6/TI 860 ms	RF2 160	2	320 x 192	5 mm	Interleave42		3:57
3D FSPGR5.5	1.4	IR PREP 500 ms	8		1	256 x 224	1.5 mm	128 locs/ 27 volume		5:43

CONCLUSION

Imaging at 3 T presents different challenges compared with 1.5 T mandating careful attention to the choice of pulse sequence parameters to achieve high quality. Signal-to-noise ratio was greatest for the FSE sequence. Proper management of the tradeoffs related to ETL choice and interleaved scan profiles leads to improved image quality or faster scan times.

KEY WORDS: Protocol, 3 T, brain

The authors of this work have indicated the following affiliations/disclosures: General Electric Medical Systems: Comprehensive research agreement.

Paper 322 Starting at 3:16 PM, Ending at 3:24 PM

Comparison of the Differences of Fractional Anisotropy Map and Tractography between 6-Direction Diffusion Tensor Imaging and 12-Direction Diffusion Tensor Imaging on 3 T Scanner

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Durham, NC

PURPOSE

To compare the differences of fractional anisotropy (FA) and tractography between 6-direction diffusion tensor imaging (DTI) and 12-direction DTI on 3 T.

MATERIALS & METHODS

Four healthy volunteers and 4 patients with brain gliomas underwent single-shot spin-echo echo-planar DTI of both 6 directions and 12 directions on Siemens 3 T scanner. Same study was repeated on the following day for the four glioma patients. Two patients repeated the same study before and after operation. All parameters (TR/TE, 8800/80, thickness/distance, 3 mm/0; b = 0, 1000; NEX, 4) were same for the two sequences except the number of directions and scan time (3 min vs 6 min). Contrast-to-noise ratio (CNR) between compact white matter (WM) and gray matter (GM) and visual conspicuity between WM and GM on FA map were evaluated. Regions of interest (ROIs) were placed on genu and splenium of corpus callosum and bilateral posterior limb of internal capsule to represent the compact white matter. Regions of interest were put on globus pallidus and gray matter of temporal lobe to represent the deep gray matter (DGM) and peripheral gray matter (PGM). Contrast-to-noise ratio 1 = (FA WM-FA DGM)/SD DGM; CNR2 = (FA WM-FA PGM)/SD PGM, SD, standard deviation. For tractography, two ROIs were chosen with one covering the whole internal capsule at the level of roof of the 3rd ventricle and another covering the half ipsilateral brain stem at the level of cerebral peduncle. Fiber number which passed through those two ROIs and mean FA values were recorded. All the tracking parameters were the same for both 6- and 12-direction tractographic processing. Then fiber numbers and FA values on the contralateral side were recorded by placing the corresponding ROIs at the same level. Paired t-test was used to analyze the difference between the two sequences.

RESULTS

Fractional anisotropy values of GM and their SD were significantly lower on 12-direction FA map than on 6-direction one. The CNRs between compact WM and deep/or peripheral GM were significantly higher on 12-direction FA map than on 6-direction map. The conspicuity between WM and GM on 12-direction FA map was superior to that on 6-direction map. Fiber numbers delineated on 6-direction tractography were significantly more than those on 12-direction tractography. Mean FA values on 6-direction tractography also were significantly higher than on 12-direction tractography. Pseudofibers generated by the artifacts between the interface of brain parenchyma and peripheral cerebral spinal fluid are significantly more on 6-direction tractography than on 12-direction one.

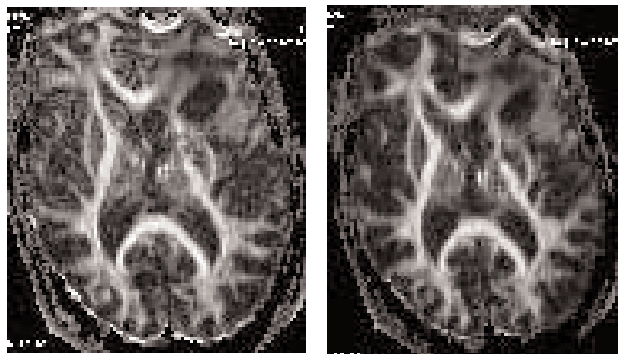


Figure 1 (left). FA map generated by 6-direction DTI. Figure 2 (right). FA map generated by 12-direction DTI.

CONCLUSION

Fractional anisotropy map obtained by 12-direction DTI is superior to that obtained by 6-direction DTI in terms of contrast and conspicuity between white matter and gray matter. An increase in the quality of the tractography on 12-direction DTI also was observed. This is probably due to its lower noise levels, which resulted in fewer extraneous artificial fiber calculations.

KEY WORDS: DTI, FA map, tractography

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of a DTI task card made by Massachusetts General Hospital (software program) for tractography.

Paper 323 Starting at 3:24 PM, Ending at 3:32 PM

Comparison of Signal-to-Noise Ratio, Contrast-to-Noise Ratio, Image Quality, and Anatomical Conspicuity between 1.5 and 3.0 T for Clinical Neuroimaging

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New York, NY

PURPOSE

MR imaging in medicine and basic research has seen a steady growth with an increase in magnetic field strength. The installation of high-field strength (i.e., 3 T and above) systems has led to these systems being utilized more extensively for clinical neuroimaging. The purpose of this study is to determine differences in signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), image quality, and anatomical conspicuity of clinical neuroimaging between 1.5 and 3.0 T.

MATERIALS & METHODS

Eighteen patients were studied with conventional MR imaging T1-weighted before and after contrast administration, T2-weighted, and FLAIR of the head at 1.5 and 3.0 T. Signal intensity was measured by drawing user-defined regions of interest of the same size and shape. Signal-to-noise ratio was measured by dividing the mean signal intensity of tissue A by the standard deviation of the background noise outside of the body. Contrast-to-noise ratio was determined by subtracting the mean signal intensity of tissue A from that of tissue B, and dividing this result by the standard deviation of the background noise outside of the body. Two readers blinded to the

patient demographics, clinical presentation, diagnosis, and study field strength reviewed the same studies performed at both magnetic field strengths. All studies were examined for conspicuity of anatomical structures, such as basal ganglia, vessels, gray-white differentiation, cerebellar and brainstem structures, as well as for motion, susceptibility, flow, and chemical shift artifacts. Each reader also was asked to determine whether each sequence was performed at 1.5 or 3.0 T.

RESULTS

Precontrast T1-weighted images performed at 3.0 T show a 29–48% increase in SNR ($p = 0.007, 0.02, 0.0009$ for white matter, gray matter and CSF, respectively) and a 33% increase in CNR between white and gray matter ($p = 0.004$). T2-weighted images demonstrated a significant difference in the SNR of white matter and gray matter ($p = 0.0003$ and 0.03 respectively) but not CNR for white matter and gray matter. There was no significant difference in SNR and CNR with postcontrast T1-weighted images and FLAIR images. Scoring for two readers demonstrated increased conspicuity of anatomical structures, such as basal ganglia, vessels, gray-white differentiation, peri-vascular spaces, cerebellar and brainstem structures at 3.0 T but increased artifacts such as motion, susceptibility, flow, and chemical shift compared to 1.5 T. Reader 1 correctly identified the field strength in 75/105 sequences. Reader 2 correctly identified the field strength in 102/105 sequences.

CONCLUSION

The results suggest that SNR and CNR improve for precontrast T1-weighted images at 3.0 T with increased anatomical conspicuity for clinical neuroimaging. However, there is increased susceptibility, flow, and chemical shift artifact at higher field.

KEY WORDS: High field MR imaging, 3.0 T, neuroimaging

Paper 324 Starting at 3:32 PM, Ending at 3:40 PM

Apparent Diffusion Coefficient Changes in Cerebellum and Deep White Matter with Acute Alcohol Ingestion

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PURPOSE

Acute alcohol ingestion causes a range of cognitive and motor deficits, including severe cerebellar ataxia. In addition, chronic alcohol use has been linked to cerebellar atrophy and cell loss which is disproportionate to supratentorial cerebral injury. This study was undertaken to investigate the temporal and regional diffusion changes in the human cerebellum and cerebrum in response to acute alcohol ingestion.

MATERIALS & METHODS

Three healthy adult volunteers were studied on a total of four occasions. Diffusion-weighted echo-planar imaging was performed using a 3 T Intera MR unit (Philips Medical Systems, Best, NL) over the whole brain (22 slices, 5 mm) using a b-value of 1000s/mm² in x, y, and z directions as well as a b-

value of 0 s/mm². Images were acquired at baseline, prior to alcohol ingestion, and approximately 60, 75, 90, and 120 minutes after ingestion of 200-220 ml of 40% ethanol (1 ml/kg ethanol), diluted with an equal volume of cordial. Average apparent diffusion coefficient (ADC) maps were constructed using the EasyVision postprocessing workstation at each timepoint. Regions of interest containing at least 20 pixels were drawn in cerebellum and deep white matter (DWM) and were interrogated at each timepoint. Breath alcohol content was assessed using a digital alcometer, calibrated to provide measurement of blood alcohol content (BAC). Peak change in ADC was compared for each region with baseline ADC determination, using a paired t-test.

RESULTS

Apparent diffusion coefficient DC values at baseline were 0.723 +/- 0.005 mm²/s (DWM) and 0.719 +/- 0.012 (cerebellum). Blood alcohol content values rose over the time-course of the experiment from 0 to 0.67 +/- 0.08%% (promille), approximately equal to the legal definition of intoxication for the purposes of motor vehicle driving. The ADC showed a 2% alcohol-mediated decrease in DWM (0.708 +/- 0.009, $p < 0.05$) and a striking 7% decrease in cerebellum (0.672 +/- 0.007, $p < 0.01$).

CONCLUSION

Acute alcohol ingestion at intoxicating doses is linked to a 7% decrease in ADC for the cerebellum and 2% decrease for deep cerebral white matter. Disproportionate involvement of the cerebellum on ADC mirrors the clinical deficits of acute ataxia and chronic cerebellar atrophy seen with alcohol use. Potential mechanisms for observed ADC decreases could include acute cytotoxic edema, energy failure, direct cellular toxicity, membrane stiffening, or osmotic effects. Acute toxic effects of alcohol vary across different regions of the brain, and preferentially affect the cerebellum.

KEY WORDS: Alcohol, diffusion, metabolic

Paper 325 Starting at 3:40 PM, Ending at 3:48 PM

Postoperative Assessment of External Carotid-Internal Carotid Bypass by MR Digital Subtraction Angiography Using Parallel Imaging

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PURPOSE

Our purpose was to evaluate the feasibility of fast 3D MR digital subtraction angiography (DSA) using a SPEEDER technique, one of parallel imaging methods, in combination with a 3D fast field-echo sequence and a segmented k-space sampling technique in the postoperative assessment of external carotid (EC)-internal carotid (IC) bypass surgery.

MATERIALS & METHODS

On a 1.5 T imager, a 3D fast field-echo sequence (TR/TE/excitations = 3.1/0.9/1, flip angle = 20 degrees, matrix = 128 x 256, field of view = 26 x 28 cm, reduction factor = 2) was used. The slab was 75 mm thick with 15 5 mm partitions that were interpolated to 30 2.5 mm partitions. We obtained 30 scans of the slab and intravenously injected

7 ml of gadolinium at a rate of 3 ml/sec during scanning. We subtracted source images of one early phase from those of subsequent phases followed by postprocessing with a maximum-intensity-projection technique. We obtained MR DSA images from eight patients (four males and four females aged 42-68 years). They comprised seven patients after superficial temporal artery (STA) middle cerebral artery (MCA) anastomosis and one patient after EC MCA anastomosis using a graft that had been performed for stenosis or occlusion of the MCA or internal carotid artery. The MR DSA images were assessed visually regarding visualization of the anastomosis as well as of distal flow comparing with 3D TOF MR angiograms obtained on the same occasion. We also compared MR DSA images with conventional angiograms in three patients.

RESULTS

The technique achieved a temporal resolution of as short as 0.8 sec. In seven patients, patency of the STA MCA anastomosis was better demonstrated than on 3D TOF MRA. Furthermore, in these patients, MR DSA well visualized good distal perfusion that was not visualized fully on 3D TOF MRA. In the remaining one patient, MR DSA provided images that revealed failure of bypass surgery suspected on 3D TOF MRA. In the three patients whose MR DSA and conventional DSA were compared, they showed good correspondence.

CONCLUSION

Fast MR DSA using the parallel imaging technique can be a valuable method to evaluate the postoperative status of EC-IC bypass. Quantitative analysis of MR DSA images, which is at present under development by us, may provide information of perfusion in the scanned area.

KEY WORDS: MR digital subtraction angiography, parallel imaging, EC-IC bypass

Paper 326 Starting at 3:48 PM, Ending at 3:56 PM

Reassessment of the Reproducibility of Postprocessing of Computed Tomography Perfusion (CTP) Data

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PURPOSE

To define the intra and inter-analyzer variability of quantitative cerebral blood volume (CBV), cerebral blood flow (CBF), and mean transit time (MTT) measurements derived from computed tomographic perfusion (CTP) maps.

MATERIALS & METHODS

Raw data derived from dynamic CTP examinations performed on 19 different subjects were postprocessed twice by each of three operators – two experienced CT technologists and one neuroradiologist (DF) – using a commercially available software program. Criteria for the selection of postprocessing parameters were prospectively optimized to maximize reproducibility. Parenchymal ROIs (regions of interest) derived from each map (CBV, CBF and MTT) were compared. Decisions made by each analyzer during postprocessing were assessed.

RESULTS

The variability in parenchymal ROI values expressed as coefficients of variation (CV; i.e., the standard deviation over the mean $\times 100$), was 12.2, 17.8 and 11.1 percent for measurements of CBV, CBF and MTT, respectively. The least experienced of the two CT technologists demonstrated significantly greater intra-observer variability ($p < 0.001$) than the more experienced CT technologist and the neuroradiologist. The variability in CBV and CBF measurements attributable to postprocessing was significantly less than that reported in a previous study in which different criteria were applied for the selection of postprocessing parameters.

CONCLUSION

Optimization of postprocessing parameters, specifically, the postenhancement image selection, significantly reduces the variability attributable to the postprocessing of dynamic CTP data using a commercially available software program. Postprocessing may be performed by an experienced CT technologist with an intra-observer reproducibility equal to that of a neuroradiologist. Variability attributable to postprocessing must be taken into consideration if quantitative CBV, CBF and MTT values are to be used to guide clinical decisions or as endpoints in cerebrovascular research studies.

This paper was selected to receive the Gabriel H. Wilson Best Paper Award by the Western Neuroradiological Society (WNRS) at its 35th Annual Meeting held in October, 2003.

Paper 327 Starting at 3:56 PM, Ending at 4:04 PM

Transcranial Ultrasound Brain Perfusion Assessment with Contrast Burst Imaging

Hoelscher, T. • Wilkening, W. • Meves, S. • Draganski, B. • Voit, H. • Bogdahn, U. • Przuntek, H. • Poster, T.

University of California San Diego
San Diego, CA

PURPOSE

The purpose of this study was to prove the reliability and reproducibility of brain perfusion assessment with an ultrasound contrast specific imaging mode in a two center trial.

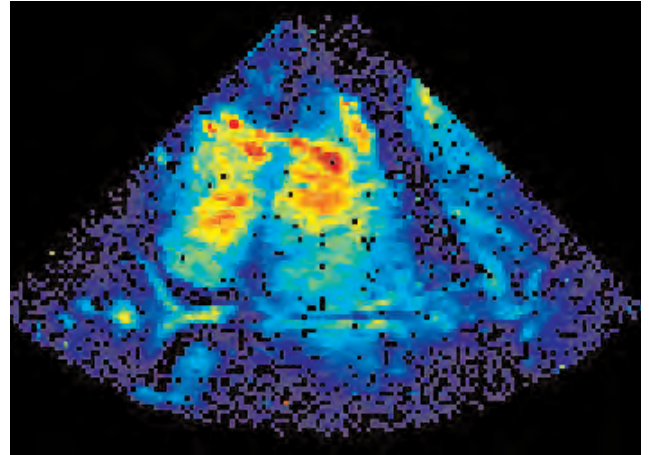
MATERIALS & METHODS

A total of 32 individuals without known cerebrovascular disease were included into the study. The contrast burst imaging (CBI) studies were performed ipsilateral in an axial diencephalic scanning plane after intravenous administration of 1.75 ml of a perfluorogase-filled echo contrast agent. Off-line time intensity curves (TIC) were generated and the parameters maximum peak intensity (PI) and time to peak intensity (TPI) were calculated in the following anatomical regions of interest (ROI): thalamus anterior (ROI_{TA}), thalamus posterior (ROI_{TP}), lentiforme nucleus (ROI_{LN}), white matter (ROI_{WM}), and one of the main vessels (ROI_{MV}). Both centers used identical study protocols, machinery equipment, and settings, respectively. The statistical analysis was done in a blinded and comparative fashion.

RESULTS

In 306 out of 320 ROIs appropriate time intensity curves could be generated. In both centers, the interindividual comparison of TPI revealed statistical significance in the comparison of a main vessel structure with any parenchymal

ROI, whereas no significant differences were seen between the parenchymal ROI among themselves. In contrast, PI varied widely interindividually, but the inter-ROI comparison revealed statistical significance in most of the cases, according to the following pattern: a) lentiforme nucleus > thalamus post./ant. and white matter region, b) thalamus post./ant. > white matter region, and c) main vessel > any parenchymal structure. The same results were achieved in both centers independently. The only mismatch was seen in the comparison of thalamus ant. vs thalamus post., where a statistical significant difference (thalamus post. > thalamus ant.) was assessed only in center 1.



CONCLUSION

The study demonstrates for the first time that with a contrast specific imaging mode the results of transcranial ultrasound brain parenchymal perfusion assessment are reproducible. Both overall and single center analysis rendered comparable results to a great extent.

KEY WORDS: Transcranial ultrasound, brain perfusion, contrast burst imaging

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of Optison made by Mallinckrodt for transcranial assessment.

Paper 328 Starting at 4:04 PM, Ending at 4:12 PM

Digital Subtraction Topography: Development of a Novel High-Definition CT Angiogram that Eliminates Metal Artifact

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¹University of Wisconsin, Madison, WI, ²General Electric Corp., Waukesha, WI

PURPOSE

Cerebrovascular noninvasive imaging in evaluation of patients who have undergone prior aneurysm clipping or coiling is limited significantly by metal artifact in many cases. We have developed a novel technique for manipulating the raw data obtained during a standard CT angiogram that yields 2D topographic, slice, and reconstructed 3D images that are free of metal artifact.

MATERIALS & METHODS

Ten patients underwent a standard CT angiography (CTA) protocol that was revised using identical scan parameters and table position for the precontrast and contrast bolus studies. The raw data from the contrast bolus projection then was subtracted from the original noncontrast raw data projection. The subtracted data set was concatenated to yield 924 topograms, similar to a scout topogram, representing each of the gantry angles that data were acquired. This yielded a series of 2D topograms and standard CT slices of the cerebral vasculature. The acquired slices then were reconstructed into 3D images.

RESULTS

Digital subtraction topography (DST) demonstrated comparable image quality to DSA in high-definition 2D topographic image sets and permitted standard 3D CT reconstruction images that were noticeably absent of metal artifact. Standard pre and postcontrast slice images were available as well.

CONCLUSION

Digital subtraction topography is a novel utilization of CT technology that manipulates the raw data to provide a high definition angiogram that is nearly equivalent to conventional DSA without the degradation from bone or metal artifacts inherent to conventional CT. This revolutionary utilization of CT technology has never been performed and is proving to be a very effective tool.

KEY WORDS: CT, aneurysm, angiogram

The authors of this work have indicated the following affiliations/disclosures: General Electric Corp.: Employee.

Paper 329 Starting at 4:12 PM, Ending at 4:20 PM

Integration of Fiber Tracking into Planning and Navigation of Neurosurgical Procedures

Dellani, P. R. • Wille, P. R. • Vucurevic, G. • Tropine, A. • Glaser, M. • Grunet, P. • Stadie, A. • Perneczky, A. • Stoeter, P.

University Clinic Mainz
Mainz, GERMANY

PURPOSE

Strategies to include results of white matter tractography into planning and navigation of neurosurgical procedures. Although diffusion tensor imaging (DTI) based fiber tracking is the only method to demonstrate white matter tracts in the living human brain, there are only few reports about its clinical value. This study was performed to show the applicability of fiber tracking in patients with brain tumors.

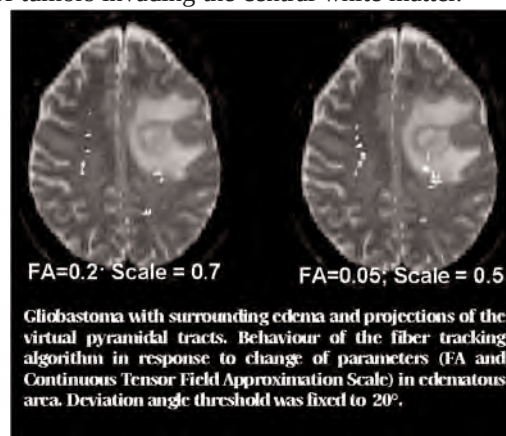
MATERIALS & METHODS

Forty patients were included: 13 meningiomas, 15 high-grade gliomas, 9 low-grade gliomas, 1 metastasis, 1 large 8th nerve schwannoma, 1 postradiation necrosis. Scanning was performed using 1.5 T Vision with 25 mT/m gradients (32 patients) and 1.5 T Sonata with 40 mT/m gradients (8 patients). Routine: T1-weighted $\pm$ CM, T2-weighted, FLAIR, 3D data sets (MP RAGE) for coregistration. DTI: EPI-based, $b = 0$ s/mm $\approx$ and 6 noncolinear directions with $b = 900$ s/mm $\approx$ (Vision) and $b = 1000, 1500, 2500$, and 5000

s/mm $\approx$ (Sonata), 3-5 mm thickness, 6 acquisitions. To improve the performance of the tracking algorithm in the peritumoral area, a subgroup of them was examined with specially high b-values. From the DTI measurements a continuous tensor field approximation was computed and tracking was performed by an in-house developed software, using a line propagation based algorithm. The algorithm had been modified by us (PD) to improve tracking on fiber crossings. Stopping criteria [fractional anisotropy (FA) = 0.2 units and deviation angle = 20°] and the scale of the continuous tensor field approximation were modified in peritumoral areas. In selected cases, the 3D MP RAGE images and the DTI data set were coregistered using SPM and AIR, allowing the precise transfer of the trajectories by in-house developed software. The images were encoded in DICOM format, allowing their transfer to the neurosurgical planning system (Dextroscope®) and a neuronavigation system (BrainLab®).

RESULTS

In all cases, the trajectories of the pyramidal tracts and of the fibers of the corpus callosum could be demonstrated. Within the peritumoral edema, but outside the enhancing part of the tumor (in meningiomas and glioblastomas), tracking results could be improved by reducing the FA threshold, by increasing the deviation angle threshold, but not by imaging with higher b-values because of declining signal-to-noise ratio. The information about the probable position of the fiber tracts was included into planning a minimal invasive surgical approach, and also used for intraoperative navigation in case of tumors invading the central white matter.



CONCLUSION

We successfully demonstrated white matter fiber tracking in patients with brain tumors and included the results into neurosurgical planning and navigation systems. In the “difficult” peritumoral edema, tracking may be improved by modification of stopping criteria, but not by imaging with increased b-values. Further studies, including electrophysiologic stimulation are planned to determine the accuracy of the method.

KEY WORDS: Fiber tracking, diffusion tensor imaging, neuronavigation

Paper 330 Starting at 4:20 PM, Ending at 4:28 PM

Quantitative Cerebral Blood Flow Measurements in Recent Stroke

Curtin, K. R. • Sakaie, K. E. • Shin, W. • Cashen, T. A. • Khawar, S. A. • Walker, M. T. • Shaibani, A. • Bernstein, R. A. • Carroll, T. J.

Northwestern University
Chicago, IL

PURPOSE

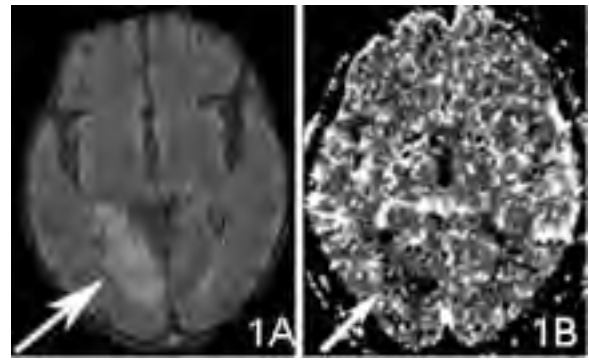
To evaluate a new, easily obtainable quantitative MR perfusion (MRP) measurement of cerebral blood flow (CBF) in patients with recent ischemic infarction.

MATERIALS & METHODS

Images were acquired on a 1.5 T scanner. Standard clinical FLAIR and diffusion-weighted images (DWI) were acquired as a baseline determination of the region of infarct. Relative CBF and cerebral blood volume (CBV) values were measured by a multislice 2D EPI acquisition (axial, FOV = 23 x 23 cm, matrix = 256 x 256, 12 slices, slice thickness = 5 mm, space between slices = 6.5 mm TR/TE/flip angle = 1660 ms/47 ms/30°) with injection of 0.1 mmol/kg Gd-DTPA. Standard indicator-dilution based theory was used to calculate mean transit time (MTT), rCBF, and rCBV. Quantitation was achieved by an independent absolute measurement of CBV based on fast T1 measurements before and after the EPI acquisition. T1 measurements were performed in a single slice with a true FISP readout of inversion recovery (axial, FOV = 20 x 19cm, matrix = 128 x 123, TR/TE = 2.95/1.48, slice thickness = 5 mm, flip angle = 40°). A global correction factor, the ratio of absolute CBV to relative CBV in the same region of healthy white matter, was used to calibrate the relative CBF values in every voxel, yielding absolute, quantitative (qCBF) values. Recently, this "book-end" technique was utilized to study healthy volunteers, resulting qCBF values of 23.4 ± 4.7 and 54.9 ± 15.2 ml/(100 g/min) in white matter and gray matter, respectively. The values are comparable to those found by the gold standard, $H_2^{15}O$ PET (23.7 ± 3.3 and 58.5 ± 7.7 ml/(100 g/min) in white matter and gray matter).

RESULTS

FLAIR and DWI images in each patient confirmed the presence of recent cerebral infarction. The FLAIR (Fig. 1A) and qCBF (Fig. 1B) in one patient is shown, demonstrating infarct with hypoperfusion (arrow). Regions of interest (ROI) were drawn to include the infarcted brain for qCBF measurements. ROIs were placed in normal contralateral tissue for comparison (Table 1). Low qCBF values are seen in the infarcted parenchyma and correspond to published values found in experimental animal models of infarct. These values also correlate with published gold standard values measured by $H_2^{15}O$ PET.



Patient	Quantitative Cerebral Blood Flow		
	Infarct CBF ml/(100 g/min)	Normal Contralateral CBF ml/(100 g/min)	Tissue
1	12.5±17	60.9±28	Occipital Gray and White Matter
2	21.2±5.8	44.5±6.6	Occipital Gray Matter
3	17.5±14	34.8±5.5	Cerebellar Gray and White Matter

CONCLUSION

We present the clinical application of a quantitative CBF program aimed at evaluating hypoperfusion in stroke patients. The independent CBV measurement used for calibration adds less than 4 minutes to a standard clinical scan, making it feasible for assessment of acute stroke. In regions of ischemia delineated by standard MR imaging, the qCBF values are consistent with previously reported values. Accurate and rapid quantitation of CBF may improve treatment of acute stroke by determining the extent of salvageable brain parenchyma.

KEY WORDS: MR, perfusion, cerebral infarction

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of: 1. MR Perfusion Software made by Siemens for MR perfusion color map construction; 2. Perfusion Software made by Northwestern University for quantitative perfusion calculation.

Thursday Afternoon

4:40 PM - 5:40 PM

Room 606 - 609

(61) ELC Lecture I: Digital Teaching
Files: An Overview of Techniques

— Gregory L. Katzman, MD

Thursday Afternoon

4:40 PM - 6:10 PM

Ballroom 6 B/C

(62) Aneurysms (ASITN)

(62a) New Devices/Treatments

— *John D. Barr, MD*

(62b) Hemodynamics

— *Ajay K. Wakhloo, MD, PhD*

(62c) Biological Treatment

— *Yuichi Murayama, MD*

Moderators: Donald W. Larsen, MD
Timothy W. Malisch, MD

leagues developed the technique of balloon-assisted coil placement. A small balloon is inflated across the neck of the aneurysm as the coils are placed, so that the coils will be directed into the aneurysm and, hopefully, assume a stable configuration without herniation into the normal artery. This technique has expanded greatly the range of aneurysms amenable to endovascular treatment. However, the balloon-assisted coiling technique is not always successful. Placement of intravascular stents to create a barrier between the normal artery and the aneurysm also has been used to facilitate treatment of aneurysms with wide and large necks. Coils then may be placed into the aneurysm through the interstices of the stent. When successful, the combined use of a stent and coils allows treatment of aneurysms with extraordinarily large necks. The major limitation of this technique has been the difficulty and risk associated with intracranial placement of stents designed for the coronary arteries. A self-expanding stent designed specifically for use as an adjunct to intracranial aneurysm treatment became available in 2002 (NeuroForm Microdelivery Stent System, Boston Scientific). This device represents a vast improvement relative to the use of coronary stents. A remaining limitation to the use of intracranial stents is that many aneurysms arise at arterial bifurcations, which complicates stent placement across the neck of the aneurysm. Liquid aneurysm treatment devices also are being developed. Relative to coils, the theoretical advantages of a liquid device include: decreased stress on the aneurysm wall during treatment, more complete filling of the aneurysm, improved occlusion of acutely ruptured aneurysms, and improved ability to conform to the aneurysm's shape. The theoretical disadvantages to liquid devices include: the necessity for temporary occlusion of the aneurysm's neck during treatment, and the possibility of unintentional embolization of the liquid into normal arteries. Micro Therapeutics' Onyx liquid embolic device is an ethylene vinyl alcohol copolymer dissolved in a dimethyl sulfoxide solvent. This device has been used recently in an investigational trial in the United States. The company is currently seeking approval for Onyx under the Humanitarian Device Exemption category, as was used also to make the Neuroform stent available. As the current generation of devices is replaced by improved technology that allows for more complete aneurysm occlusion, the advantages of endovascular therapy will continue to grow. Whether endovascular therapy at present has evolved to an equal or better alternative to surgical clipping remains debatable. However, given the rapid and continuing technological advances, there seems to be little doubt that endovascular therapy soon will become accepted as the preferred treatment for most aneurysms.

Disclosure: The author of this presentation has indicated the following affiliations/disclosures: 1. Micrus Corporation, MicroVention, Inc, Boston Scientific: Stock options; 2. Micro Therapeutics, Inc., Siemens Medical Systems, Inc.: Research grant; 3. Cordis Neurovascular, Inc.: Consulting fees; 4. Boston Scientific: Speakers' Bureau.

New Devices/Treatments

John D. Barr, MD

LEARNING OBJECTIVES

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

- 1) Evaluate the latest interventional techniques for endovascular aneurysm treatment
- 2) Assess the patient selection criteria for using the latest interventional devices and techniques for endovascular aneurysm treatment

PRESENTATION SUMMARY

The first device for direct endosacular aneurysm treatment, the Guglielmi detachable coil (GDC) system (Target Therapeutics, Natick, MA), was approved in 1995. The GDC coils were available initially in only a simple helical configuration. Difficulty with treatment of wide and large necked aneurysms was recognized quickly; the coils could not be contained within the aneurysm. Controlled detachment platinum microcoils in a variety of complex configurations now have become available from multiple manufacturers. These newer coil configurations are designed to facilitate treatment of aneurysms with larger necks. As more densely packing the aneurysm with coils was recognized as a key to durable occlusion, a variety of softer coils designed to improve the percentage of the aneurysm filled also were developed. The latest development in coil technology is the transition from bare metal coils to coils with bioactive coatings. It is hoped that these bioactive coils will induce a healing response within the aneurysm to produce a more effective and durable occlusion. At this time, limited human data are available to support this theory. Endovascular treatment of wide and large necked aneurysms remains challenging. Moret and col-

Hemodynamics

Ajay K. Wakhloo, MD, PhD

LEARNING OBJECTIVES

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

- 1) Differentiate in vitro and in vivo methods to study hemodynamics in aneurysm
- 2) Relate the impact of local flow dynamics on tissue remodeling
- 3) Evaluate flow dynamics and its implication for therapeutic approach

PRESENTATION SUMMARY

Hemodynamic mechanisms for the initiation and progression of intracranial aneurysms currently are being studied. Attention has focused on flow impingement areas, oscillating shear stress, and pressure together with the very specific intracranial arterial wall construct. Different in vitro and in vivo modalities are presented here to study the complex intracranial flow, which may contribute to remodeling of the arterial wall. Flow analysis within the aneurysm/parent artery complex may help to understand why under certain circumstances a coiled aneurysm may reopen. This may improve the development of minimally invasive endovascular therapy and noninvasive strategies.

Disclosure: The author of the presentation has indicated that he will be discussing/presenting an unapproved/investigative use of stents. The stents are made by Boston Scientific, Cordis Neurovascular, Johnson & Johnson.

Biological Treatment

Yuichi Murayama, MD

Dr. Yuichi Murayama was born in Tokyo, Japan in 1964. He graduated and received his M.D. degree from Jikei University School of Medicine in 1989. He received Neurosurgical training at Jikei University. After completing his residency in 1995, Dr. Murayama joined the Division of Interventional Neuroradiology at the University of California Los Angeles. He completed Interventional Neuroradiology training under Fernando Vinuela, M.D. In 2001, he became an Associate Professor of Radiological Science and Co-Director of Leo G. Rigler Radiological Research Center at the University of California Los Angeles School of Medicine. Currently, Dr. Murayama is also a Professor and Director of Endovascular Neurosurgery at Jikei University. His academic interests include Endovascular Neurosurgery and development of biocompatible therapeutic devices, such as Matrix detachable coil system.

LEARNING OBJECTIVE

Upon completion of session, participants will be able to:

- 1) Evaluate new imaging techniques and procedure options for diagnosis and management of stroke and cerebral aneurysm in the adult population.

PRESENTATION SUMMARY

In the last decade, endovascular therapy using detachable metallic coil such as GDC has proven to be a successful alternative for the treatment of intracranial aneurysms. The most important limitation of current coil embolization is the possibility of aneurysm recanalization, particularly in wide necked or large/giant aneurysms. Platinum coils produce a mild biological response when delivered into an aneurysm. Acceleration of intraaneurysmal clot organization and fibrosis may be a solution to preventing aneurysm recanalization after endovascular treatment. Matrix coil is a new bioactive, bioabsorbable coil for brain aneurysm therapy. Matrix coils consist of thin platinum coils covered with a bioabsorbable, polymeric material (polyglycolic acid/lactide). This device was approved by FDA in February 2002. To date more than 1500 patients were treated with the Matrix detachable coil system world-wide. Initial clinical results were excellent and as safe as the GDC system. Long-term angiographic evaluation demonstrated healing reaction of treated aneurysms. Treatment with Matrix exhibits an improved tissue organization in aneurysm when compared to the standard GDC treatment. Longer angiographic follow-ups are needed to document the long-term efficacy. Further ongoing research also will be presented.

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Disclosure: The author of this presentation has indicated an affiliation with Boston Scientific: Consulting fees.

Thursday Afternoon

4:40 PM - 6:10 PM

Ballroom 6 A

(63) Advanced Imaging Seminar - Functional Mapping

(63a) Functional MR Imaging Basics

— Jonathan H. Burdette, MD

(63b) Functional MR Imaging Clinical Applications

— Andrei I. Holodny, MD

(63c) MEG and MSI "From Squiggles to Surgery"

— Steven M. Stuffelbeam, MD

(63d) Functional MR Imaging Analysis Techniques

— James J. Pekar, PhD

Moderators: Timothy P.L. Roberts, PhD
Howard A. Rowley, MD

radiologists will find themselves increasingly asked to perform fMRI studies. This portion of the fMRI Advanced Imaging Workshop will address the techniques used to perform fMRI, with emphasis on the fMRI techniques used most commonly for clinical examinations. Discussed will be how one gets from an idea of an fMRI experiment to the pretty, colorful results seen commonly in the literature today. Following a brief discussion of the history of functional brain imaging in general, the specific areas to be covered will include the Physiologic basis of blood oxygen level dependent (BOLD) imaging, paradigm design, rapid MR scan techniques necessary for fMRI studies, data analysis, and MR compatible equipment used to present various paradigms to the subjects. Various useful paradigms already being used for clinical fMRI also will be presented. At the end of this session, the attendee should better understand why and how fMRI works and most of the steps necessary for successful implementation of fMRI into a standard practice.

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Disclosure: The author of this presentation has indicated an affiliation with GE Medical Systems: AVR Research Fellowship grant.

Functional MR Imaging Basics

Jonathan H. Burdette, MD

Dr. Jonathan H. Burdette is an Assistant Professor of Neuroradiology at Wake Forest University School of Medicine in Winston-Salem, North Carolina. His current research in fMRI focuses on abnormal cross-modal integration of multiple sensory systems (audition and vision) in dyslexia and aging.

LEARNING OBJECTIVES

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

- 1) Assess the neurophysiologic underpinnings of the BOLD technique
- 2) Define the main types of tasks performed in the MR scanner
- 3) Express a basic level how the MR data is processed to create the colorful blobs of activation
- 4) Analyze the few steps required to implement functional MR imaging (fMRI) into a clinical practice

PRESENTATION SUMMARY

Everyone has seen the beautiful pictures in the press of multicolored blobs of brain activity "lighting up" on exquisite, high-resolution MR images. These pictures are generated using functional MR imaging (fMRI). While it has been primarily a research tool so far, as familiarity with the technique grows among referring physicians and the lay public,

Functional MR Imaging Clinical Applications

Andrei I. Holodny, MD

PRESENTATION SUMMARY

Functional MR imaging (fMRI) is an extremely powerful tool which has revolutionized the study of the human brain. Aside from the basic sciences, fMRI has clear applications to clinical medicine. Recent advances will make fMRI studies accessible for clinical radiologists, including those in private practice. This will bring this commanding technology to the aid of our patients. Functional MR imaging can and should be used in the clinical setting; however, there are differences in application of fMRI between research subjects and clinical patients that radiologists should be aware of. I shall use the example of patient with a brain tumor. First, the clinical fMRI exam should be individualized depending upon the specific location of the tumor and the patient's symptomatology. For example, in a patient with a motor strip lesion resulting in paralysis, one may perform a passive motion or sensory paradigm instead of the standard finger tapping. Second, the paradigms that the patient will perform in the magnet should be practiced prior to the actual fMRI. Patients with brain tumors may be more forgetful, may fatigue faster, and may have more difficulty concentrating on the task at hand than healthy volunteers. Third, while in the magnet, the patient has to be monitored to make sure that s/he is performing the paradigm correctly. This is especially problematic for paradigms

involving higher cortical functions. Functional MR imaging has a number of known limitations. However, the radiologist, understanding the physics of MR imaging and having the capacity to interpret the routine MR images that come with the fMRI data, is in a unique position to appreciate these limitations and avoid the associated pitfalls.

MEG and MSI "From Squiggles to Surgery"

Steven M. Stufflebeam, MD

LEARNING OBJECTIVES

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

- 1) Define the neuromagnetic inverse problem and discuss the practical implementations of a solution
- 2) Define methods of using MEG to determine hemispheric dominance of language
- 3) Review methods for intraoperative localization using MEG and other functional imaging methods

PRESENTATION SUMMARY

Magnetoencephalography (MEG) has been used for well over a decade to aid the neurosurgeon in localizing both abnormal tissue to be resected, and healthy essential areas of the brain, which are to be preserved during a procedure. We will review the neuromagnetic inverse problem and possible solutions, with emphasis on localization accuracy while preservation of temporal information. This is essentially distilling hundreds of squiggles into a few critical images that can be used efficiently in the operating room suite. The use of MEG in epilepsy and the use of both focal inverse source estimates, such as the equivalent current dipole method, and distributed solutions such as the minimum norm estimate. The use of language mapping in order to determine hemispheric dominance, and the use of MEG for regional language mapping also will be reviewed.

Functional MR Imaging Analysis Techniques

James J. Pekar, PhD

James J. Pekar is Associate Professor of Radiology at The Johns Hopkins University in Baltimore, Maryland, where he also serves as Manager and Research Coordinator of the F.M. Kirby Research Center for Functional Brain Imaging (<http://mri.kennedykrieger.org>) at Kennedy Krieger Institute. Dr. Pekar received his B.S. in Physics from M.I.T. and his Ph.D. in Biophysics from the University of Pennsylvania. He was National Research Council Research Associate at the In Vivo NMR Research Center, National Institutes of Health, and then Senior Staff Fellow at the Laboratory of Diagnostic Radiology Research, National Institutes of Health. From 1995 through 1998 he was on the faculty of the Department of Neurology, Georgetown University Medical Center. Dr. Pekar's research interests include exploratory approaches to functional brain mapping and the biophysics of functional MR imaging.

LEARNING OBJECTIVES

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

- 1) Distinguish how information about brain function is encoded in raw fMRI data
- 2) Assess how raw fMRI data is processed to yield brain activation maps

PRESENTATION SUMMARY

Blood oxygenation level dependent functional MR imaging (BOLD fMRI) exploits deoxy-hemoglobin as an endogenous paramagnetic susceptibility contrast agent to sensitize dynamic susceptibility-weighted MR acquisitions to the hemodynamic concomitants of brain activation. Reduction of the resulting large (ca. Gbyte) whole-brain four-dimensional spatio-temporal raw data sets to activation maps has been achieved for the most part with massively univariate inferential modeling: voxel-wise testing of prior temporal hypotheses [a.k.a. regression, correlation, and general linear model (GLM)]. Bayesian approaches may have advantages in analyzing these rich data, especially when simultaneous data from other modalities (e.g., EEG and EMG, but also monitors reporting upon physiologic sources of variance in BOLD fMRI data, such as pulse oximeter, respiratory bellows, and end-tidal expired concentration of CO₂) are available for "multimodal" or "multispectral" analysis. Multivariate exploratory approaches, such as spatial independent component analysis (ICA), may reveal structure in BOLD fMRI data resulting from unanticipated brain activity; the timings of these "brain networks" then may be entered as additional hypotheses into a GLM. Thanks to advances in computer performance, analysis of BOLD fMRI data can be performed on laptops. Much excellent free fMRI analysis software is available for download. Rapid analysis of BOLD fMRI data with "real time" display of brain activation maps has been demonstrated for GLM and with ICA. Alternative sources of fMRI contrast, such as cerebral blood flow (CBF) and cerebral blood volume (CBV)-based fMRI methods, can provide synergistic data to explore.

Disclosure: The author of this presentation has indicated an affiliation with Philips Medical Systems: Research grant. The author of the presentation has indicated that he will be discussing/presenting an unapproved/investigative use of Intera MR Scanner (1.5 & 3.0 Tesla). The Scanner is made by Philips Medical Systems.

Thursday Afternoon

5:40 PM - 6:10 PM

Room 606 - 609

(64) ELC Roundtable: Q & A with
Today's Speakers

– *Dale A. Charletta, MD*

– *Gregory L. Katzman, MD*

– *Todd B. Parrish, PhD*

– *Richard L. Wiggins, III, MD*

Notes:

Thursday

NOTE ABOUT SCANNED IMAGES: *Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2004.*

Friday Morning

8:00 AM - 9:41 AM

Ballroom 6 B/C

(65a) Interventional: Aneurysms (Scientific Papers 331 - 343)

See also Parallel Sessions

(65b) *Adult Brain: Functional Imaging (fMRI, MSI, MRS, PET)*

(65c) *Interventional: General*

(65d) *Adult Brain: Vascular Imaging*

Moderators: Charles M. Strother, MD
Fernando Vinuela, MD

Paper 331 Starting at 8:00 AM, Ending at 8:08 AM

Coil Occlusion of 2029 Intracranial Aneurysms: Results of Initial Treatment

Henkes, H. • Fischer, S. • Weber, W. • Liebig, T. • Mariushi, W. M. • Kuehne, D.

Alfried Krupp Krankenhaus
Essen, GERMANY

PURPOSE

To evaluate the efficacy and safety of the endovascular coil occlusion of intracranial aneurysms.

MATERIALS & METHODS

Retrospective data registry of the first endovascular treatment sessions of 2029 intracranial aneurysms in 1748 patients, treated in a single center between November 1992 and November 2003. The analysis comprised both angiographic and clinical results (e.g., degree of aneurysm occlusion, frequency and nature of procedural complications, clinical outcome).

RESULTS

A total of 2029 aneurysms (1098 ruptured, 931 unruptured) in 1748 patients were treated by endovascular coil occlusion. A straightforward single-catheter technique was used most frequently (87.6 %). The degree of occlusion of the aneurysmal sac was 90-100% (considered sufficient to prevent hemorrhage) in 1759 aneurysms (86.7%). Sixteen hundred seventy-four (82.5%) analyzed treatment sessions were accomplished without a procedural complication. Thrombo-embol-

ic events (n = 195, 9.6%) and periprocedural aneurysm rupture (n = 72, 3.5%) were the most frequently observed complications. The clinical outcome after the first treatment session was (according to the Glasgow Outcome Scale, GOS) graded as I (dead) (n = 86, 4.3%), II (n = 61, 3.0%), III (n = 219, 10.9%), IV (n = 132, 6.6%) or V (no disability) (n = 1508, 75.2%), with still undefined outcome in 23 aneurysms. Previous hemorrhage and procedural complications but not aneurysm location mainly influenced the clinical outcome.

CONCLUSION

These data confirm the efficacy and relative safety of the endovascular coil occlusion of intracranial aneurysms, based on the experience of a dedicated high-volume neuroendovascular center.

KEY WORDS: Aneurysm, endovascular treatment, Coils, detachable

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of fibered electrolytically detachable coils made by Dendron/MTI for the treatment of intracranial aneurysms (this product has no FDA approval for this use).

The authors of this work have indicated the following affiliations/disclosures: 1. EFMT, Bochum, Germany: Consultant; 2. Dendron/MTI, Irvine, CA: Research grant; 3. ev3, Germany: Consultant.

Paper 332 Starting at 8:08 AM, Ending at 8:16 AM

Coil Treatment of 2029 Intracranial Aneurysms: Follow-Up Data in 1063 Aneurysms

Henkes, H. • Fischer, S. • Weber, W. • Liebig, T. • Miloslavski, E. • Kuehne, D.

Alfried Krupp Krankenhaus
Essen, GERMANY

PURPOSE

To evaluate the mid- and long-term results of the endovascular coil occlusion of intracranial aneurysms.

MATERIALS & METHODS

Retrospective data registry of the angiographic and clinical results of the subsequent endovascular treatment sessions and follow-up examinations of 1063 out of 2029 (52.4%) intracranial aneurysms which underwent follow-up examinations, carried out in a single center between November 1992 and November 2003.

RESULTS

In 1063 aneurysms the first angiographic follow-up examination was performed at a mean interval of 23.5 months after the first treatment session and showed a 90-100% aneurysm occlusion in 771 aneurysms (72.5%). A degree of occlusion

below 90% was found in 292 aneurysms (27.5%), and 203 (69.5%) of these aneurysms had been occluded previously at 90-100%. Detailed anatomical analysis revealed any type of recurrence in 337 aneurysms (31.7%), which was attributed mostly to either coil compaction ($n = 271$, 25.5%) or coil migration into thrombus ($n = 28$, 2.6%). Repeated treatment sessions after the first coil treatment were carried out as follows: 1 in 154 aneurysms, 2 in 33 aneurysms, 3 in 11 aneurysms, 4 in 4 aneurysms, 5 in 1 aneurysm, 7 in 1 aneurysm, 8 in 1 aneurysm. In 26 aneurysms (1.2%) rupture after endovascular coil occlusion was documented. For 922 patients clinical follow-up data comprising 35676 patients-months (equivalent to 2973 patient-years) are available. In 816 of these 922 patients (88.5%) the clinical condition at a mean of 37 months after the 1st treatment session was (according to the Glasgow Outcome Scale) graded as GOS V.

CONCLUSION

The clinical long-term results after the endovascular coil occlusion of intracranial aneurysms are obviously good. Minor degrees of neck recurrence are observed frequently and mostly are due to coil compaction. The low rate of aneurysm (re-)bleeding after coil treatment is encouraging but confirms the need for rigorous angiographic follow-up examinations and eventually retreatments.

KEY WORDS: Aneurysm, endovascular treatment, follow-up

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of fibered electrolytically detachable coils made by Dendron/MTI for the treatment of intracranial aneurysms (this product has no FDA approval for this use).

The authors of this work have indicated the following affiliations/disclosures: 1. EFMT, Bochum, Germany: Consultant; 2. Dendron/MTI, Irvine, CA: Research grant; 3. ev3, Germany: Consultant.

Paper 333 Starting at 8:16 AM, Ending at 8:24 AM

Comparison of HydroCoil™ Embolization System, Platinum Coils, and Matrix™ in the Embolization of Experimental Aneurysms in Rabbits

Kallmes, D. F. • Ding, Y.

Mayo Clinic
Rochester, MN

PURPOSE

To evaluate and compare the performance of three products for the embolization of experimental aneurysms.

MATERIALS & METHODS

Elastase-induced, saccular aneurysms were created in 27 New Zealand White rabbits. Nine aneurysms were embolized with each of the three products evaluated in this study, the HydroCoil™ Embolization System (HES, MicroVention, Aliso Viejo, CA), platinum coils, and Matrix™ (Target Therapeutics, Fremont, CA). We compared between groups the following parameters: aneurysm size, neck size, dome:neck ratio, procedure duration, number of devices deposited, total device length deposited, angiographic occlusion score, and volumetric occlusion percentage.

Analysis of long-term angiographic data at 2, 6, and 10 weeks is in progress and is complete for the HydroCoil and platinum groups. Histologic analysis is in progress. Groups were compared using ANOVA.

RESULTS

There was no significant difference among groups regarding aneurysm size or dome:neck ratio. There was no difference among groups regarding total device length, initial angiographic occlusion score, or procedure time. The mean number of devices for Matrix subjects was less than that for platinum ($p = .03$); mean number of devices for HydroCoil subjects was not different from other groups. Volumetric occlusion for HydroCoil (76% $\pm$ 34) was significantly greater than both platinum (31% $\pm$ 9) and Matrix (22% $\pm$ 6). Angiographic follow-up data are complete for HydroCoil and platinum subjects. For the HydroCoil cohort, angiographically stable occlusion was seen in 5 of 9 cases. Progressive occlusion was observed in the remaining 4 cases. Recanalization or aneurysm regrowth was not seen in any of the aneurysms. For the platinum coil aneurysms, stable occlusion was observed in 6 cases, progressive occlusion in 1 case, and compaction in 2 cases. Angiographic occlusion score at follow-up was greater for HydroCoil as compared to platinum ($p = .03$).

CONCLUSION

Immediate angiographic occlusion is similar among platinum, Matrix, and HydroCoil devices. Volumetric occlusion is improved using HydroCoil as compared to other devices. Compared to platinum, HydroCoil results in improved long-term occlusion rates. Additional data regarding long-term performance of Matrix devices in the rabbit model will be presented, along with histologic analysis of all three devices.

KEY WORDS: Aneurysm, animal model, coils

The authors of this work have indicated the following affiliations/disclosures: MicroVention, Inc.: Shareholder.

Paper 334 Starting at 8:24 AM, Ending at 8:32 AM

Accuracy of Algebraic and Voxel Methods for Quantifying Cerebral Aneurysm Volume by 3D Rotational Digital Subtraction Angiography: An In Vitro and In Vivo Study

Fanning, N. F. • O'Dwyer, H. • Bowden, J. • Brennan, P. • Thornton, J.

Beaumont Hospital
Dublin, IRELAND

PURPOSE

With the development of liquid embolic polymers and expandable gel-coated coils accurate assessment of the volume of an aneurysm will be valuable in guiding the volume of material required to fill the aneurysm sac and in assessing the percentage volume filling achieved. Following 3D DSA acquisition, aneurysm volume can be quantified using simple algebraic equations based on the assumption they have regular geometry or by quantification of voxel volume using dedicated software (GE Medical Systems, Buc, France). Our aim was to determine the accuracy of these various methods for calculating aneurysm volume using an in vitro model and confirm the findings in vivo.

MATERIALS & METHODS

Our in vitro model consisted of 13 latex aneurysm molds. The volumes of these experimental aneurysms were measured 5 times using a micropipette and the mean volume was taken as the true volume of the model aneurysm. Following 3D DSA acquisition, the volumes of the experimental aneurysms were calculated, first, on a dedicated workstation by multiplying the total number of voxels belonging to the aneurysm by the corresponding voxel volume (0.3 mm^3 for the 23 cm field of view used) and, second, by simple algebraic equations assuming the aneurysms were either ellipsoid or cylindrical. We next quantified aneurysm volume in 50 patients with cerebral aneurysms comparing the voxel and algebraic methods for volume estimation.

RESULTS

In our in vitro study the voxel volume method for aneurysm quantification was significantly more accurate than the algebraic method. The mean percentage deviation of the voxel volume from the true volume was $3.7 \pm 3.5\%$ (range -3.3 to 7.9%; $p = 0.9$). Algebraic methods based on the assumption that the aneurysms were cylindrical, resulted in a significant overestimation in volume size (mean percentage overestimation of the cylindrical volume method from the true volume was $36.9 \pm 22.3\%$; range -15.9 to 82.4%; $p = 0.018$). Assuming the aneurysms were ellipsoid resulted in no correlation with true aneurysm volume (mean percentage deviation of the ellipsoid volume method from the true volume was $63.9 \pm 109.7\%$; range -35.7 to 327.6%). Using the voxel method as a standard in the in vivo model, we confirmed that the cylindrical method overestimated aneurysm volume ($22.4 \pm 34\%$; $p = 0.004$) and that calculations based on the assumption that aneurysms in vivo are ellipsoid were not correlated with voxel aneurysm volume.

CONCLUSION

The voxel volume method is accurate in quantifying true aneurysm volume. Aneurysms in vivo do not conform to simple algebraic geometry. Calculations based on the assumption that aneurysms are cylindrical results in significant overestimation in volume size, with no correlation with true size when aneurysms are assumed to be ellipsoid. Assessing percentage aneurysm filling with any embolic agent using an algebraic method would be inappropriate.

KEY WORDS: Volume, aneurysm, 3D DSA

Paper 335 Starting at 8:32 AM, Ending at 8:40 AM

Calculation of the Volume Embolization Ratio in Small Aneurysms Treated with a Single Detachable Coil

Goddard, J. K. • Moran, C. J. • Cross, D. T. • Derdeyn, C. P.

Mallinckrodt Institute of Radiology
St. Louis, MO

PURPOSE

Dense coil packing of intracranial aneurysms is an important goal of endovascular embolization. However, because of small size, some aneurysms only can be treated with a single embolization coil. Previous authors have described a significant correlation between the stability of coiled aneurysms and a volume embolization ratio greater than 20-33% (1, 2, 3). Usefulness of the ratio in predicting stability of small aneurysms treated with a single detachable coil has not been

determined. We retrospectively analyzed small aneurysms treated with a single Guglielmi detachable coil (GDC) in order to determine if the volume embolization ratio is predictive of stability.

MATERIALS & METHODS

The volume embolization ratio is determined for 20 consecutive small (all < 7 mm diameter) intracranial aneurysms treated with a single embolization coil from August 1997 to April 2003. The aneurysms were identified in 20 different patients, 12 females and 8 males, ranging in age from 21 to 72 years (mean and median age 48 years). Sixteen aneurysms were in the anterior circulation and four were in the posterior circulation. Eight aneurysms had ruptured previously. Aneurysm volumes are calculated assuming that these small lesions are spherical in shape. The largest aneurysm dimension, estimated by comparison to anatomical landmarks, was used for volume calculation. Coil volumes are as per manufacturer specification. Volume embolization ratio is calculated by the formula (coil volume/aneurysm volume) $\times 100\%$. Stability was assessed by angiographic follow-up. New aneurysmal filling on the follow-up exam was considered to be a recurrence.

RESULTS

Follow-up angiographic assessment was conducted at 6 $\pm$ 6 months after initial treatment. The average volume embolization ratio for all aneurysms was 12.4 $\pm$ 8.2% (range 1.5 to 28.2%). Twenty percent of the aneurysms had a packing density greater than 20%. One large (6 $\times$ 10 mm) and three small (< 1 mm) recurrences were identified. Three of the four recurrent aneurysms (one basilar apex and two anterior communicating) had ruptured previously. The fourth recurrence was a previously unruptured anterior communicating aneurysm. The average embolized volume for unchanged aneurysms was 12.6 $\pm$ 7.7%. Volume embolization ratios for the recurrent aneurysms were: 3.4, 3.9, 11.5 and 28.2% (average 11.8 $\pm$ 11.6%). There was not a significant difference between these two groups ($P = .86$).

CONCLUSION

Average embolization ratio for aneurysms treated with a single coil was less than the recommended packing density of 20-33% (1, 2, 3). Coil embolization ratio was not predictive of recurrence in small intracranial aneurysms treated with a single detachable coil.

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KEY WORDS: Aneurysm, embolization, ratio

Paper 336 Starting at 8:40 AM, Ending at 8:48 AM**Clinical and Morphologic Long-Term Results of Basilar Tip Aneurysms Treated by Reversal of Flow**

Weill, A. • Roy, D. • Guilbert, F. • Raymond, J.

Centre Hospitalier Universite Montreal, Hopital Notre-Dame
Montreal, PQ, CANADA

PURPOSE

To determine the long term clinical and morphologic results of saccular basilar tip aneurysms treated by reversal of flow.

MATERIALS & METHODS

From October 1996 to August 2003, 11 patients (9 females, 2 males) (44-77 years old, average 54 years) had a saccular basilar tip aneurysm treated by reversal of flow. Five aneurysms were giant, 4 were large. Five were ruptured previously but none were treated this way in acute phase. Six aneurysms were treated because of progressive mass effect, 5 after recurrence of selective treatment. Clinical follow-up ranged from 2 to 54 months (average 21 months). Morphologic follow-up (with CT and/or MR imaging and or angiography) ranged from 0 to 54 months (average 15 months).

RESULTS

Reversal of flow was obtained after occlusion of vertebral arteries below PICAs. In one case a surgical by-pass between the superficial temporal artery and the posterior cerebral artery was necessary. Parent vessel occlusion led to 2 strokes (1 fatal, 1 minor). Clinical long-term results: No bleeding or rebleeding occurred during follow-up period. From the 5 patients with symptoms related to mass effect who survived, 2 improved, 2 continued to deteriorate and 1 remained unchanged (average observation period 17 months). Morphological long-term results: 2 aneurysms decreased in size or completely thrombosed, 4 aneurysms did not change, 1 continued to growth, 3 were not followed (2 patients refused imaging, 1 is pending). Specific analysis of the flow at the level of the neck of the aneurysm at the time of the parent vessel occlusion gives some valuable information but can not predict with certainty the evolution of the aneurysm since the flow might continue to change with the recruitment of collateral circulation as demonstrated when late control angiograms are performed (3/3).

CONCLUSION

Long-term clinical and morphologic results of bilateral vertebral artery occlusion for basilar tip aneurysm treatment are uncertain. Therefore this treatment modality should be weighed carefully before being attempted.

In the future, virtual models on computer might be helpful by showing the impact of flow modification on aneurysm growth and might allow for a more accurate selection of patient. However, this selection probably will never be perfect, because collateral circulation development after parent vessel occlusion is difficult to predict and might change the posterior circulation flow distribution with time.

KEY WORDS: Aneurysm, parent vessel occlusion, basilar tip

Paper 337 Starting at 8:48 AM, Ending at 8:56 AM**Endovascular Coil Embolization of Middle Cerebral Artery Aneurysms**

Doerfler, A. • Wanke, I. • Goericke, S. • Sandalcioglu, E. • Stolke, D. • Forsting, M.

University of Essen
Essen, GERMANY

PURPOSE

To analyze technical feasibility, safety, and efficacy of endovascular coil embolization in a consecutive series of ruptured and unruptured aneurysms of the middle cerebral artery (MCA).

MATERIALS & METHODS

Thirty-nine patients with ruptured (n = 16) or unruptured (n = 25) MCA aneurysm (n = 41) were considered for endovascular therapy with detachable coils. Twenty-two patients had an acute SAH; of which six patients had a ruptured aneurysm in a different location. In 17 patients the MCA aneurysm was an incidental finding. Five patients had a residual aneurysm after surgical clipping. Patients with SAH were classified as H&H; Grade I (7), II (8), III (6), and IV (1). Aneurysm size was: < 6 mm (24), 6-10 mm (13), 11-25 mm (4). At the time of treatment three patients had severe vasospasms. Occlusion rate was divided into total (100%), subtotal (95-99%), and incomplete (< 95%) occlusion. Follow-up angiography and clinical evaluation based on the Glasgow Outcome Scale (GOS) were performed at 6 months.

RESULTS

In 5/39 patients coil embolization of the aneurysm was not performed (4) or failed (1) because of an unfavorable angioanatomy (n = 4) or severe vasospasm (n = 1). In 34/39 patients complete occlusion could be achieved in 35 aneurysms (total n = 20; subtotal n = 15), and incomplete in one. Procedural complications included coil protrusion into the parent artery (1), and thromboembolic artery occlusion (4). Selective thrombolysis resulted in recanalization in 3/4 cases, with persistent neurologic deficit (ND) in one patient. There was no procedure-related death, procedural morbidity was 2.6%. Of the 15 patients with subtotal occlusion eight patients progressed to total occlusion during follow-up, two patients had recanalization of the aneurysm due to coil compaction. Both patients were retreated. One patient had slight recanalization without coil compaction. No patient rebled. Glasgow Outcome Scale at 6 months for the embolized patients with SAH (n = 19) was: GR (14), ND (4), D (1), and GR for all patients embolized for an incidental aneurysm. In four of the five patients in whom endovascular therapy was not performed neurosurgically clipping was performed, with complete aneurysm occlusion in three and incomplete in one patient. Clinical outcome after 6 months according GOS was GR (3) and ND (1).

CONCLUSION

Endovascular coil embolization can be performed safely and effectively in selected MCA aneurysms. Anticoagulation management is of great importance in this setting. Our results demonstrate that initial subtotal aneurysm occlusion might progress to total occlusion during follow-up.

KEY WORDS: Aneurysm, middle cerebral artery, embolization

Paper 338 Starting at 8:56 AM, Ending at 9:04 AM**Endovascular Treatment of Posterior Circulation Aneurysms: Alternative Approaches**

Ghodke, B. V.

University of Washington
Seattle, WA**PURPOSE**

Endovascular treatment has been established as an effective treatment modality, most successfully in the posterior fossa. There are many instances when the treatment is limited by unfavorable anatomy, like extreme tortuosity in the verte-brobasilar system, atherosclerotic disease with stenoses in these vessels, vasospasm, catheter and wire-induced injury, dissections, etc. The purpose of this article is to describe our experience with alternative approaches to aneurysms in the posterior fossa. The hardware, technical modifications, and case selections will be discussed.

MATERIALS & METHODS

We present four representative cases of aneurysms in the posterior circulation admitted at the University of Washington Medical Center and Harborview Medical Center between 2002 and 2003. All patients underwent a complete diagnostic angiogram and were referred for endovascular treatment of the aneurysms. Case 1 had an aneurysm on the distal right vertebral artery involving the right PICA origin treated by approaching the aneurysm through the left vertebral artery while protecting the right PICA via the right vertebral artery. Case 2 had a distal left PICA aneurysm treated via a direct puncture of left vertebral artery at C1-2 level. There was extreme tortuosity of the left vertebral artery while the right vertebral artery was ending in PICA. Case 3 had a basilar tip aneurysm treated through combined left PCOM and vertebral approach as the patient had a wide-necked aneurysm and remodelling was performed through the left PCOM across the aneurysm neck. Case 4 had a right P2-3 segment aneurysm treated through the right PCOM, due to severe spasm in the vertebral arteries on attempts to catheterize them.

RESULTS

Case 1, we were able to preserve the right PICA with occlusion of the aneurysm. Cases 2-4, we were able to deploy coils in the aneurysms successfully. All cases had successful outcomes with angiograms showing stable occlusion.

CONCLUSION

With ongoing advances in the endovascular hardware, catheters, guide wires and improved imaging equipment, it is possible to approach complex intracranial lesions via alternative approaches as described and increase the number of lesions that can be treated successfully.

KEY WORDS: Aneurysm, GDC, embolization

Paper 339 Starting at 9:04 AM, Ending at 9:12 AM**Fibered Electrolytically Detachable Platinum Coils for the Endovascular Occlusion of Intracranial Aneurysms: Clinical Experiences and Analysis of 474 Aneurysms**

Liebig, T. • Henkes, H. • Fischer, S. • Brew, S. • Weber, W. • Miloslavski, E. • Mariushi, W. • Kühne, D.

Alfried Krupp Krankenhaus
Essen, GERMANY**PURPOSE**

To determine the safety and clinical efficacy of electrolytically detachable coils with attached nylon fibers (Sapphire Detachable Coil System, MTI, Irvine, CA) for the endovascular treatment of intracranial aneurysms in comparison to bare platinum coils.

MATERIALS & METHODS

Between November 1992 and October 2003 a total number of 2029 aneurysms was treated by endovascular occlusion with electrolytically detachable coils in 1748 patients. In this series, nylon-fibered platinum coils were used in 474 aneurysms solely or in combination with bare coils from various manufacturers. Retrospective analysis was done with respect to clinical status, and numerous parameters concerning individual aneurysm characteristics (e.g. location, neck width, fundus diameter). Treatment-related facts included the use and percentage of fibered coils, occlusion rate, procedural complications, early clinical outcome and Glasgow Outcome Scale (GOS) scores. Finally, follow-up results like occlusion rate, occurrence and cause of recurrence, incidence of posttreatment hemorrhage, and clinical long-term follow-up were included. Angiographic follow-up data were available for 904 aneurysms treated with bare coils and for 156 aneurysms treated with fibered coils. Statistical analysis for comparison between aneurysms treated with either bare or fibered coils was done by means of logistic regression and matched pairs analysis. Only treatments with available data for all matching variables were used resulting in 421 matched pairs.

RESULTS

Both logistic regression and matched pairs analysis showed a statistically improved early occlusion rate if fibered coils had been used (roughly 96% occlusion rate of 90%-100% with the use of fibered coils vs 78% in the matched pairs analysis and 84% with logistic regression with the exclusive use of bare coils). However, the amount of fibered coils calculated as percentage of coil length did not seem to have a relevant impact. Procedures with fibered coils did not lead to a higher rate of thromboembolic events. Actually, there was a statistically insignificant trend towards a reduced frequency of this kind of complication (8% fiber vs 10% bare coils). Also, the clinical outcome was insignificantly better in the group treated with fibered coils determined by both postprocedural outcome and GOS. Analysis of the anatomical properties showed no differences between the groups treated with bare and fibered coils in terms of neck width, fundus diameter, and anatomical location. As expected, a higher occlusion rate was achieved in aneurysms with smaller neck and fundus independent from the type of coil used. On follow-up angiography, there was a statistically nonsignificant trend towards a lower rate of recurrence secondary to coil compaction in the group treated with fibered coils but these data

were compromised by the fact that up to date, only 156 out of 474 aneurysms underwent angiographic follow-up after fibercoil treatment.

CONCLUSION

In our series, fibered electrolytically detachable platinum coils exhibit significantly improved occlusion rates over bare platinum coils. Statistically insignificant trends towards a reduced rate of thromboembolic events, an improved clinical outcome, and a reduced recurrence rate remain subject to validation by more angiographic long-term follow-up data to be collected.

KEY WORDS: Aneurysm, endovascular, fibered coils

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of fibered electrolytically detachable coils made by Dendron/MTI, Irvine, CA for the treatment of intracranial aneurysms.

The authors of this work have indicated the following affiliations/disclosures: 1. EFMT, Bochum, Germany: Consultant; 2. ev3: Consultant; 3. Dendron/MTI, Irvine, CA: Research grant.

Paper 340 Starting at 9:12 AM, Ending at 9:20 AM

First Year Single Center Experience with the Matrix Detachable Coils for Treatment of 139 Consecutive Intracranial Aneurysm Cases: Technical and Clinical Outcomes Including 6-Month Angiographic Follow-Up

Chaloupka, J. C. • Johnson, M. C. • Ugurel, M. S. • Lee, S. • Tejada, J. • Hsu, S. W.

University of Iowa Hospitals and Clinics
Iowa City, IA

PURPOSE

We present the worlds' largest single center clinical series of IC aneurysms treated with the Matrix detachable coils in which immediate/short term technical and clinical efficacy is assessed, as well as 6-month angiographic follow-up in our first 50 patients.

MATERIALS & METHODS

Over a 12-month period, 159 consecutive aneurysm cases were treated by endovascular surgery at our center, of which 139 were treated successfully with Matrix coils. Any aneurysm treated with at least one Matrix coil was included in the study. Conventional co-axial microcatheter techniques were used to access and fill the aneurysms with coils. In most cases, aneurysms were treated with a combination of Matrix and other bare platinum coils (GDC, Micrus, and Orbit). Wide-neck aneurysms were treated mostly adjunctively with neck bridging microstents (Neuroform), or occasionally balloon neck remodeling. Systemic heparinization was used in all cases during ES, while either oral (ASA and Plavix) and/or intravenous (Aggrastat) antiplatelet therapy was administered when stenting was performed. Conventional angiographic and clinical outcome criteria were used for immediate, 6-week, and 6-month follow up assessments.

RESULTS

Patient female:male ratio = 13:7. Aneurysm sizes varied from 2-28 mm (median = 6 mm). All anatomical sites were encountered with most common: ICA paraclin. (N = 33), ACoA (N = 31), MCA (N = 27), ICA-PCoA (N = 22), and Basilar tip (N = 17). Attempted Matrix placement was unsuccessful in 5/142 cases (3.5%). Good or excellent angiographic obliteration was noted in 130/139 cases (93%), although small neck remnants were noted in 20% of cases on immediate control angiography. A wide spectrum of Matrix-bare platinum coil blends were encountered (20-100%) with an average of 45%. Four patients suffer major complications directly attributable to ES, which included 1 overpacking, 1 aneurysm perforation, 1 delayed coil migration into the parent artery, and one distal perforation from a wire exchange used for NF placement. A detailed accounting of additional technical and short term clinical outcomes will be tabulated and presented. Six-month angiographic follow-up to date has been obtained in 48 patients. Clinically significant recanalization of an aneurysm treated with Matrix, which required retreatment was seen in 11 cases, resulting in an overall retreatment rate of 22.9%. There appeared to be no correlation with size, location, or proportion of Matrix coils used and the need for retreatment.

CONCLUSION

From a purely technical perspective, our experience with the Matrix coils has been overall very favorable, although we have encountered certain problems and limitations with these coils (e.g., framing compartmentalization, relatively increased stiffness), which likely were responsible either for earlier encountered complications or current inability to utilize the device universally in the full spectrum of technical applications. Clearly, with increasing cumulative experience, our group is now routinely using the system in nearly every aneurysm. The overall retreatment rate of 22.9% compares very well with previously reported series, particularly when considering that our series represents an unselected patient population (i.e., ES is the primary treatment modality). Retrospective studies are now ongoing to assess the actual impact Matrix coils may have had on retreatment rates compared to aneurysms treated with bare-platinum coils.

KEY WORDS: Matrix coils, endovascular surgery

The authors of this work have indicated the following affiliations/disclosures: Boston Scientific, Cordis Neurovascular, Micrus: Consultant, grant funding, honoraria.

Paper 341 Starting at 9:20 AM, Ending at 9:28 AM**Effects of Intraarterial Nicardipine on Cerebral Blood Flow of Patients with Subarachnoid Hemorrhage-Induced Vasospasm as Measured by Cine CT Perfusion**

Nogueira, R. G. • Lev, M. H. • Roccatagliata, L. • Rabinov, J. D. • Hirsch, J. A. • Ogilvy, C. S. • Pryor, J. C. • Gonzalez, G. R. • Rordorf, G. A.

Massachusetts General Hospital
Boston, MA

PURPOSE

To determine the effects of the administration of intraarterial (IA) nicardipine on the cerebral hemodynamics of patients with vasospasm following subarachnoid hemorrhage (SAH).

MATERIALS & METHODS

Five post-SAH patients with clinical and transcranial Doppler findings suggestive of vasospasm were evaluated by CT angiography (CTA) and concomitant first-pass quantitative cine CT perfusion (CTP) immediately before angiographic evaluation for possible vasospasm treatment. Angiographic vasospasm was confirmed in all patients. CTA/CTP was repeated following IA administration of Nicardipine. Maps of mean transit time (MTT), cerebral blood volume (CBV) and cerebral blood flow (CBF) were generated and analyzed by a blinded investigator using the ALICE software (Denver, CO). Corresponding regions of interest (ROI) from the bilateral middle cerebral artery territories, and whenever possible the bilateral anterior cerebral artery territories, were selected from both pre and posttreatment scans and compared in order to establish the changes in CBF, CBV and MTT after IA Nicardipine.

RESULTS

In four out of five patients, both CBF and MTT improved significantly in the affected regions in response to Nicardipine therapy [mean increase in CBF 56% (range 8-162%, $p = 0.01$), mean decrease in MTT 36% (range 5-68%, $p = 0.0007$)]. In one patient, we were unable to observe an improvement in flow parameters secondary to slice selection differences between the pre and posttreatment examinations.

CONCLUSION

Intraarterial nicardipine infusion improves CBF and MTT in ischemic regions in patients with SAH-induced vasospasm. Our data complements, at the tissue level, the previously reported favorable effects of IA nicardipine seen with angiographic studies. Quantitative CTP may provide a surrogate marker for monitoring the success of treatment strategies for clinical trials of patients with SAH-induced vasospasm.

KEY WORDS: Nicardipine, vasospasm, CT perfusion

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of Nicardipine made by ESP Pharma, Inc. and Roche for cerebral vasospasm treatment.

Paper 342 Starting at 9:28 AM, Ending at 9:36 AM**Intraarterial Nicardipine vs Papaverine for Cerebral Vasospasm Following Subarachnoid Hemorrhage**

Rabinov, J. D. • Singhal, A. B. • Hirsch, J. A. • Hoh, B. L. • Conrad, L. K. • Carter, B. S. • Ogilvy, C. S. • Badjatia, N. • Pryor, J. C.

Massachusetts General Hospital
Boston, MA

PURPOSE

To compare outcomes of patients treated with intraarterial nicardipine and/or angioplasty with patients treated with papaverine and/or angioplasty for cerebral vasospasm following subarachnoid hemorrhage.

MATERIALS & METHODS

Retrospective analysis was used to identify and gather patient data. In the 2-year period 2000-2001, 26 patients were treated for cerebral vasospasm using angioplasty and/or intraarterial papaverine. In the subsequent 2-year period 2002-2003, 47 patients were treated with angioplasty and/or intraarterial nicardipine. Covariates = age ($>$ or $<$ 50 years), sex, Hunt Hess grade (1-3) (HH), Fisher score (1-3), vasospasm severity on angiogram (mild/moderate/severe), therapy given (papaverine and/or angioplasty or nicardipine and/or angioplasty), and number of treatments. Outcome variables: modified Rankin score (mRS), death, neurointensive care length of stay (ICU LOS) and total length of stay (LOS). Multivariate analysis for outcomes after adjusting for age, Fisher, Hunt Hess, angioplasty, vasospasm severity, number of treatments.

RESULTS

Papaverine group - total 26 patients, mean age 52.1 years, 8 males, mean HH grade 3.3, Fisher scale score 2.9, 8 required > 2 treatments, all 26 had concomitant angioplasty, mRS 4.39 (22 with mRS 3 to 6; 21 with mRS 4 to 6, 7 deaths); NICU LOS 18.1 days, total LOS 28.0 days. Nicardipine group - total 47 patients, mean age 51.7 years, 12 males, mean HH grade 3.2, Fisher scale score 2.8, 10 required > 2 treatments, only 6 had concomitant angioplasty, mRS 4.15 (41 with mRS 3 to 6; 32 with mRS 4 to 6, 11 deaths); NICU LOS 17.8 days, total LOS 26.3 days. Multivariate analysis - HH grade significantly associated with mRS ($p < 0.001$) and death ($p < 0.001$); patients needing more than 2 treatments had longer total LOS ($p = 0.025$). No difference in any outcome variable between nicardipine and papaverine groups. Anecdotally, limitation to nicardipine for intracranial pressure issues was only 2/47 patients, and it was used in several patients with cardiac impairment without complication.

CONCLUSION

Our results suggest that intraarterial nicardipine is as effective as papaverine and/or angioplasty for treatment in patients with subarachnoid hemorrhage. This regimen can avoid the risks of angioplasty and the complications encountered with papaverine.

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KEY WORDS: Vasospasm, subarachnoid hemorrhage, aneurysm

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of: 1. Papaverine made by American Regent for cerebral vasospasm; 2. Nicardipine made by Weyth Laboratory for cerebral vasospasm.

Paper 343 Starting at 9:36 AM, Ending at 9:41 AM

Hemorrhagic Foreign Body Granulomas Following Stent-Assisted Aneurysm Embolization

Tong, F. C. • Abruzzo, T. A. • Cawley, C. M. • Dion, J. E.

Emory University School of Medicine
Atlanta, GA

PURPOSE

We describe a 59-year-old female with an incidentally discovered left superior hypophyseal artery aneurysm that initially was treated endovascularly with bare platinum coils with subsequent recurrence. The recurrence was retreated endovascularly in a combined stent-coil procedure 7 months later in which there was unraveling and removal of a Hydrogel-coated aneurysm coil. Her postoperative course was complicated by right upper extremity weakness, right hemiparesis, and disorientation with multiple small subcortical infarcts by follow-up MR imaging consistent with thromboemboli. She had a new unexplained 5 mm focus of intraparenchymal hemorrhage in the lateral left temporal lobe on postoperative day 7 and was ultimately discharged to home on postoperative day 15 with only mild residual right extremity weakness. Seven days post discharge the patient presented to her local emergency room with a 12 x 5 x 3 cm intraparenchymal hemorrhage in the left frontal lobe with a small amount of overlying subarachnoid hemorrhage. The patient demonstrated no verbal or motor response with fixed and dilated pupils. Medical care was withdrawn at the request of the family and an autopsy was obtained demonstrating disseminated foreign body granulomas in the left cerebral hemisphere.

MATERIALS & METHODS

Benchtop stent and coil embolization was performed with video analysis utilizing identical catheter, microguidewire, and stent treatment materials for analysis of the stent-coil unraveling. This was performed using a 10 mm silicone sidewall aneurysm and pulsatile flow model using phosphate buffered saline. S7 (AVE) and Neuroform 2 (Boston Scientific) stents were placed across the aneurysm neck

models and aneurysmal catheterization was performed using new Excelsior (Boston Scientific) microcatheters and new Agility-14 (Cordis) microguidewires. A series of bare platinum, Hydrogel-coated (Microvention), and suture-coated (Boston Scientific) were placed through the stents into the aneurysms with video recording. Gross and histologic analysis of the brain specimen was performed including identical H&E staining of the Hydrogel material. A cell block specimen containing several brain granulomas was submitted for Fourier transform infrared spectroscopy for analysis of the foreign body material.

RESULTS

Video analysis of the stent-coil procedural recreation demonstrated ejection of multiple white and blue fibers from the microcatheter following placement in the aneurysm. This was the case for both studied microcatheters. This material was collected on and sent for Fourier transform infrared spectroscopy which showed that it was consistent with cotton fibers and cellulose. Gross and histologic analysis of the treated aneurysm showed no evidence of rupture. Histologic analysis of the brain specimen demonstrated extensive disseminated foreign body granulomas containing multinucleated histiocytic giant cells many containing blue string-like nonpolarizing material. Fourier transform infrared spectroscopy of the foreign body granulomas in the cell block demonstrated findings also consistent with cotton fibers and cellulose.

CONCLUSION

This patient demonstrated clinical and imaging findings of cerebral emboli resulting in the formation of foreign body granulomas that are likely the cause of her delayed intraparenchymal hemorrhage. These granulomas demonstrate the presence of cotton fibers and cellulose matching the foreign body ejected from the microcatheters during video analysis which was confirmed by Fourier transform infrared spectroscopy. Further study into the etiology of these foreign body fibers is necessary so that the source can be identified and eliminated.

KEY WORDS: Foreign body, granuloma, embolization

Friday Morning

8:00 AM - 9:36 AM

Ballroom 6 A

**(65b) Adult Brain: Functional Imaging
(fMRI, MSI, MRS, PET)
(Scientific Papers 344 - 355)**

See also Parallel Sessions

(65a) Interventional: Aneurysms

(65c) Interventional: General

(65d) Adult Brain: Vascular Imaging

Moderators: Cesare Colosimo, MD
Andrei I. Holodny, MD

Paper 344 Starting at 8:00 AM, Ending at 8:08 AM

Comparison of Functional MR Imaging Guidance to Electrical Cortical Brain Mapping for Targeting Selective Motor Cortex Areas: A Study Based on Intraoperative Stereotactic Navigation for Motor Cortex Stimulation in Neuropathic Pain

Pirotte, B. • Neugroschl, C. • Wikler, D. • Denolin, V. • Voordecker, P. • Massager, N. • Brotchi, J. • Levivier, M. • Balériaux, D. L. F.

Hospital Erasme, Universite Libre de Bruxelles
Brussels, BELGIUM

PURPOSE

To assess, regardless of the clinical result, the contribution of combining the functional MR imaging (fMRI) to the intraoperative brain mapping (iBM) to improve the quality of the targeting method for epidural chronic motor cortex stimulation (MCS) in refractory central and neuropathic pain.

MATERIALS & METHODS

Eighteen patients (10 female/8 male, mean age 55.6 years) suffering from refractory central [ischemic/traumatic (12 cases)] and neuropathic pain [trigeminal neuropathy (6 cases)] underwent surgery for the implantation of an epidural MCS device under general anesthesia and with a frameless surgery navigation system used for the image-guided targeting procedure. The authors used the standard procedure of cortical iBM with somatosensory evoked potentials and motor cortex bipolar stimulation as functional targeting method. Preoperatively, the motor cortex activation after motor tasks of both hands (and foot/face when affected by pain) were systematically studied by fMRI investigating. Functional MR data obtained were analyzed with the Statistical Parametric Mapping 99 software with an initial analysis threshold corresponding to $P < 0.001$.

Intraoperatively, the stereotactic coordinates of the central sulcus and those of the motor target defined by MR imaging and iBM were correlated spatially into the navigation system to the contours of the fMRI-activated motor areas in all patients. The authors assessed the contribution of combining fMRI to the standard, iBM-guided procedure to improve the quality of the preoperative functional targeting method.

RESULTS

Pain relief was obtained in 11/18 patients. Excellent matching between the contours of the fMRI-activated areas and the iBM target of the hand on precentral cortex was observed (focus of highest electrical wave found within the contours of the fMRI-activated cortical area) in 11 patients and used as functional target for MCS. The fMRI-activated area helped to confirm the target of the hand in 6 other patients in which iBM was impaired by artifacts or wave attenuation and therefore not strictly reproducible or concordant (taking as functional target from iBM recordings the one that was projected within the contours of fMRI-activated area). The fMRI-activated area helped to confirm the target of the foot/face in 3 patients in which iBM was not strictly reproducible or concordant. Finally, in one patient, iBM data were fully informative to allow targeting while fMRI data were impaired by patient's poor cooperation during imaging process.

CONCLUSION

Although specific aspects of fMRI technique must be validated prior to its reliable use in routine image-guidance, these preliminary data show that: 1) fMRI-guidance can provide data matching those obtained from standard and independent method used for functional targeting, 2) the combination of both techniques could help in validating fMRI-guidance as a valid adjunct to iBM for improving the quality of the functional targeting procedure. Since appropriate targeting is crucial to obtain pain relief, the combination of stereotactic fMRI to iBM could improve the efficacy of MCS on the alleviation of pain.

KEY WORDS: Functional MR imaging, brain mapping, motor cortex

Paper 345 Starting at 8:08 AM, Ending at 8:16 AM

Tongue Articulation Functional MR Imaging: Absence of Lateralization in the Deaf

Shibata, D. K. • Zhong, J.

University of Washington
Seattle, WA

PURPOSE

The congenitally deaf often have limited speech skills and thus the neural control of the vocal apparatus might be expected to be relatively underdeveloped. The purpose of this functional MR imaging (fMRI) study was to localize brain activity associated with simple tongue articulation movements in the deaf and hearing and determine if the presence or absence of speech alters the cortical representation.

MATERIALS & METHODS

Fourteen students from a deaf college with prelingual hearing loss and relatively poor speech skills were compared to 14 hearing subjects. All subjects were right-handed and

between 18 and 31 years of age. The task in both groups was to make a brief series of nonvocal movements of the tip of the tongue against the midline palate with mouth closed. An event-related design was used to minimize head motion. Echo-planar 2D spiral whole brain scanning was performed at 1.5 T (GE) with T-test analysis and Talairach-based inter-subject averaging (SPM 99).

RESULTS

Group analysis revealed overall fairly similar bilateral inferior perirolandic cortex activations in the two groups. However, the deaf showed additional temporal lobe activity, primarily in the posterior left superior temporal gyrus (anterior to usual auditory cortex) but also the right posterior middle temporal gyrus. Additionally, cerebellar activity was more prominent in the deaf. Both groups showed similar expected SMA and basal ganglia activation. The hearing showed a focus of activation not seen in the deaf in the left supramarginal gyrus extending towards the angular gyrus. A region of interest comparison was made along the posterior aspect of the inferior frontal gyrus (corresponding to the inferior aspect of Broca's area) which showed an overall left lateralization in the hearing but not the deaf.

CONCLUSION

These results support the hypothesis that the primary tongues sensory-motor center is relatively invariant in regard to speech experience, but secondary sites which may show developmental variation. The involvement of the temporal lobe in the deaf correlates with increased involvement in this lobe in other tasks (1). Left lateralization of articulation has been shown to be dependent on the linguistic content (2, 3), but also may be related to other factors such as chewing dominance (4). These differences may be relevant clinically in understanding the linguistic impact of lesions or for pre-operative planning in deaf patients.

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KEY WORDS: Brain, tongue, deafness

ACKNOWLEDGMENTS

The National Technical Institute of the Deaf at the Rochester Institute of Technology, Rochester, NY provided assistance with subjects.

Sam McKennoch, Electrical Engineering, University of Washington, assisted with data analysis.

Paper 346 Starting at 8:16 AM, Ending at 8:24 AM

Lack of Education and Intelligent Quotient Effects on Hippocampal Activity in a Functional MR Imaging Experiment

Mohamed, M. A.¹ • Yousem, D. M.¹ • Kusevic, I.¹ • Caffo, B. S.^{2,1} • Cristinzio, C.¹ • Honeycutt, N. A.¹ • El-Dieb, A.¹ • Yassa, M. A.¹ • Bassett, S. S.¹

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PURPOSE

As more individuals are now enrolled in clinical functional MR imaging (fMRI) studies, we sought to determine the effect of education and intelligent quotient (IQ) on fMRI hippocampal activation. We hypothesized that fMRI activation (maximum amplitudes and numbers of activated voxels) will be correlated inversely with the subject's years of education and IQ.

MATERIALS & METHODS

Eighty-nine normal subjects were involved in this study (48 males and 41 females) with their age ranging from 48-83 years (mean 63 years, SD 7.9). The subjects' years of education and performance on the North American Adult Reading Test (NAART) were recorded. The NAART scores were converted to both Verbal and Full Scale IQ. The fMRI paradigm used was a block design with a series of memory encode (learning), memory recall (memorizing), and baseline (rest) periods. Statistical parametric mapping (SPM99) was used and activation maps were produced for each subject. Our regions of interest (ROI) were defined as the right and left hippocampi. Multiple regression analysis then was performed between the maximum amplitudes and voxels of activation of the different conditions and the years of education and IQ. The analysis controlled for age and gender because of our earlier findings of gender effects for this task.

RESULTS

There was no significant correlation between the years of education or IQ and the maximum activation amplitudes or the number of activated voxels for either memory encode or memory recall conditions. There was no effect of age on either amplitude or volume of activation, however, as expected from our previous report, there are gender differences.

CONCLUSION

Our results suggest that the education and IQ have little influence on the fMRI hippocampal activation in a memory task. Thus the need to control for education and IQ effects seems to be less critical in the analysis of a memory-based functional MR imaging task.

KEY WORDS: Education, intelligent quotient, fMRI

Paper 347 Starting at 8:24 AM, Ending at 8:32 AM**Multifunctional Neuroimaging: Functional MR Imaging Assessment of Occipital Lobe Pathologies with Visual Field Loss**

Szeder, V.¹ • Williams, K.¹ • Wieser, J. A.¹ • Maciejewski, M.^{1,2} • Janik, J.^{1,2} • Hacein-Bey, L.¹ • Remler, B. F.¹ • Ulmer, J. L.¹ • DeYoe, E. A.¹

¹Medical College of Wisconsin, Milwaukee, WI, ²Marquette University, Milwaukee, WI

PURPOSE

The advent of functional MR imaging (fMRI), created the opportunity to integrate structural and functional data into a comprehensive system for the diagnosis and management of different brain pathologies. Here we describe two illustrative case studies in which fMRI was used in a novel way to map visual function in and near occipital lobe sites of cerebral pathology. The resulting data were used to create unique “functional field maps” (FFmaps) that were compared directly with conventional Humphrey perimetry to assess the potential clinical utility of this approach.

MATERIALS & METHODS

Case 1: 58-year-old male with bilateral occipito-temporal infarcts. Humphrey visual field testing revealed a left hemianopsia plus partially impaired vision in the upper right quadrant with sparing of macular vision in both the upper right and lower left quadrants. Functional MR imaging visual field mapping was performed 1.5 years after the strokes. Case 2: 31-year-old female with history of migraine headaches, unresponsive to medication. Initial work-up revealed an occipital arteriovenous malformation (AVM) with no apparent visual field loss. This was followed by fMRI visual field mapping. In both cases, gradient-echo, echo-planar fMRI mapping of occipital visual cortex was performed using a video display of an expanding checkered annulus followed by a rotating checkered wedge to activate successive locations within the central 28° of the patient's visual field. Using a temporal phase mapping paradigm (DeYoe, 1996), the resulting data identified the visual field location represented by each active brain voxel within occipital visual cortex. These data were used to create FFmaps showing the pattern of normal and impaired vision within each patient's field of view. Both patients underwent Humphrey visual field testing using the 24-2 test array.

RESULTS

In Case 1, involving a post-stroke patient with chronic visual field deficits, there was a detailed correspondence between the visual field maps produced by fMRI and Humphrey perimetry including fine details such as macular sparing. In Case 2 involving a patient with an active AVM pathology, the fMRI maps revealed an undetected upper left quadrantanopsia that subsequently was verified with perimetry. However, the fMRI map also indicated a partial field loss in the lower left quadrant that could not be verified behaviorally. Thus, there was a mismatch between the fMRI and behavioral results in the second case.

CONCLUSION

Functional MR imaging-based mapping of function in the occipital lobe in and around a site of cerebral pathology was accurate in the case of chronic pathology. In the acute AVM

case, fMRI was able to show a field defect that had not been detected with confrontation testing but also indicated a larger region of impairment than could be verified behaviorally. Since the blood oxygenation level dependent (BOLD) mechanism responsible for the fMRI signal is based on a local vasoactive response linked to neuronal activity, the apparent loss of signal likely reflected a local uncoupling of this linkage. Such uncoupling may be predictive of the potential for additional vision impairment following surgical treatment of the AVM.

KEY WORDS: fMRI, vision, clinical

The authors of this work have indicated the following affiliations/disclosures: Funded by National Institutes of Health EB00843, EY13801, RR00058 and Dana Foundation.

Paper 348 Starting at 8:32 AM, Ending at 8:40 AM**MR Protocol in the Confirmatory Diagnosis of Brain Death: Analysis of 43 Cases**

Cartaxo, H. Q.¹ • Caetano-Barros, A.¹ • Branco, F. C.¹ • Costa Neto, A.¹ • Leimig, C.¹ • Loureiro, R.¹ • Santos-Filho, P. B.^{1,2}

¹Real Hospital Portugues de Beneficencia em Pernambuco, Recife, Pernambuco, BRAZIL, ²North Carolina State University, Raleigh, NC

PURPOSE

Within this work, we will demonstrate the potentials of the MR techniques of diffusion-weighted imaging, perfusion-weighted imaging, and contrast-enhanced (Gd-DTPA) angiography (CE MRA) in the diagnostic confirmation of brain death (CD) and also death of the brain stem (BSD).

MATERIALS & METHODS

Forty-three individuals with clinical suspicion of brain death were studied between 2000 and 2003. All patients were subjected to CE MRA measurements; 33 of these patients also had diffusion-weighted and perfusion-weighted imaging. All brain death cases were confirmed by MR imaging, and all medications and mechanical support were maintained until the clinical declaration of death by spontaneous cardiac arrest.

RESULTS

Contrast-enhanced MRA brain death was positive in 77% (33/43) of the patients, with 5 cases of full intracranial arterial filling, 3 cases of full arterial filling of the posterior circulation, and 2 cases of full arterial filling of the anterior circulation. Diffusion and perfusion were capable of confirming 32 of the 33 individuals with the diagnosis of brain death, and death of the brain stem. All measurements were negative in one patient, but it so happens that eventually he came out of the state of coma. Indeed, diffusion-weighted and perfusion-weighted imaging were capable of discriminating 100% of cases.

CONCLUSION

Diffusion-weighted and perfusion-weighted imaging are accurate techniques in the detection of brain death and its sub-types, and are to be prescribed in studies of inconclusive intracranial macrocirculatory tests. The complete protocol, as used by Real Imagem, requires confirmatory studies by akin groups if it is to be accepted by the normative institutions, medical community, and general public as a more inclusive and liable diagnostic tool for determining brain death and its variants.

KEY WORDS: Brain death, diffusion, perfusion

Paper 349 Starting at 8:40 AM, Ending at 8:48 AM

Brain Death Studied by Proton MR Spectroscopy: Definition of a Relaxation Time for Brain Death

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¹Real Hospital Portugues de Beneficencia em Pernambuco, Recife, Pernambuco, BRAZIL, ²North Carolina State University, Raleigh, NC

PURPOSE

The definition of a parameter “The Relaxation Time for Brain Death” - T1(BD) is herein associated with the loss of the brain spectroscopic neuronal marker metabolite N-acetylaspartate (NAA), and also with the appearance and increase in the intensity of the hypoxic marker, the doublet of lactate (Lac), as measured by proton MR spectroscopy (MRS-H).

MATERIALS & METHODS

Sixteen patients from the hospital’s neurologic intensive care unit have been studied by single voxel proton spectroscopy (SVS) in the parietal-occipital gray matter region and other locals, in a Siemens Sonata or Siemens Vision magnetons, field of 1.5 T, TE of 20 ms, and TR of 1,500 ms. The inclusion of the MRS-H sequences in the angio-resonance (MRA) and diffusion/perfusion-weighted imaging protocol of the Real Imagem service increased exam time by approximately 4 minutes per spectrum. Usually only one spectrum is sufficient per patient.

RESULTS

Brain spectra from 0.0 to 4.2 ppm attest to the final and irreversible state of patients with brain death. MR and spectroscopy measurements were performed in patients following the standard Brazilian brain death evaluation protocol, as patients were sent to our imaging unit for complementary MR angiography, diffusion, perfusion, and proton spectroscopy exams. The decay of the NAA signal from its normal average value (for the patients age group) and the appearance and growth of the Lactate doublet take place in conjunction, and are used to characterize the time, “The Relaxation Time for Brain Death” - T1(BD) herein proposed, in analogy to the mathematical definition of a usual spin lattice T1 time. In this study, one patient presented the state of “incarceration” or “locked in” where the parietal-occipital gray matter and white matter had regular MRS-H spectra and the cerebral brain stem presented an over three-day-old brain death spectrum.

CONCLUSION

The definition and determination of the parameter “Relaxation Time for Brain Death” - T1(BD) by MR spectroscopy, we believe, is a relevant and unequivocal way of predicting and establishing the moment when the legal, ethical, familial, and religious considerations are to appreciate scientifically the process of organs donation.

KEY WORDS: Brain death, spectroscopy, time

Paper 350 Starting at 8:48 AM, Ending at 8:56 AM

Role of Impaired Proprioception in Primary Writing Tremors and Writer’s Cramp: A Functional MR Imaging Study

Jayakumar, P. N. • Sahni, H. • Pal, P. K. • Balivada, S.

National Institute of Mental Health and Neurosciences Bangalore, INDIA

PURPOSE

Primary writing tremors (PWT) has been regarded both as a focal form of essential tremor and also as a variant of focal task specific dystonia writer’s cramp (WC). It is not clear whether they are different entities or form part of the spectrum of a single disorder (1, 2). Results of functional MR imaging (fMRI) across studies on patients with PWT and WC have shown both reduced and increased activations in different regions of the brain (1, 2). We hypothesized, the role of proprioception may explain differences in regional activation patterns and prospectively compared cerebral activation patterns in patients of PWT and WC with that of healthy volunteers while signing on paper and in air.

MATERIALS & METHODS

Six subjects with PWT, three with WC and six healthy volunteers were examined. All subjects in the study were right handed. The volunteers and patients had no sensory impairment or structural lesions in the brain and were not on any medication. A total of 120 blood oxygen level dependent (BOLD), single-shot EPI acquisitions were obtained with a paradigm of 3 sets of alternating periods of 40 seconds each of rest and signing on paper followed by 3 sets of alternating periods of 40 seconds each of rest and signing in air using the dominant right hand. SPM analysis was done using SPM 99.

RESULTS

Cerebral activation was depicted with a statistical threshold of $p = 0.05$ (corrected). Group analysis was done independently for each of the 3 groups of subjects for the tasks of signing on paper and signing in air. Slice and sectional overlays were studied to identify the localization of various clusters of activity and their time activity curves were plotted and 3D surface rendered. As compared to normal subjects, patients with PWT showed significant activity in primary motor (PMA) and supplementary motor areas (SMA) on both paradigms of signing on paper and in air (3). While patients with WC did not show such activities in the PMA and SMA, they showed significant activity in the contralateral cingulate gyrus and thalamus (2). Cerebellum showed reduced activation in both writer’s cramp and primary writing tremor as compared to normal subjects (Figure).

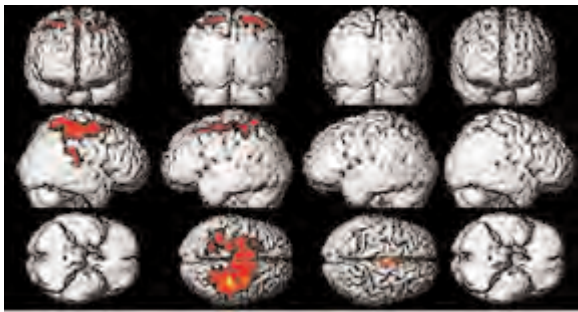


Figure: Three-dimensional rendering of fMRI activity: Patients with WT are shown in two columns on left and patients with WC in two columns on right.

CONCLUSION

Cerebral activation in patients with PWT and WC differs from healthy individuals both with respect to regions as well as patterns of activation both while writing on paper (with proprioceptive input) and in air (no proprioceptive input). This may suggest the role of differences in the impaired management of proprioceptive inputs as a possible pathophysiologic mechanism in these disorders.

KEY WORDS: fMRI, writing tremors, writer's cramp

Paper 351 Starting at 8:56 AM, Ending at 9:04 AM

Neural Substrates of Lexical-Semantic Working Memory: Imaging Speech Planning with Functional MR Imaging

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PURPOSE

Aphasic patients with lexical-semantic retention deficits have great difficulty comprehending and producing sentences in which several lexical/semantic representations must be held simultaneously (Martin & Romani, 1994; Martin & Freedman, 2001). There is some evidence that these deficits are associated with left frontal brain lesions (Romani & Martin, 1999), but this corroboration is based on a limited number of subjects. The present study used an event-related functional MR imaging (fMRI) paradigm to determine if we would find verification from young normal subjects for the involvement of left inferior frontal gyrus in maintaining semantic information during phrase production.

MATERIALS & METHODS

Seven (6 females + 1 male) young healthy volunteers participated in this protocol that used a two (response type: overt vs covert) x three (task: single word vs sentence vs phrase) event-related design (picture description paradigm). Subjects performed overt and covert tasks during separate scanning (GE 1.5 T Signa Echo Speed NV/i; TR/TE/q = 2000 ms/50 ms/90°; 12 contiguous 6 mm thick axial slices; sella to the primary sensorimotor hand area) sessions on different days. Each session consisted of seven runs including single word (e.g., "cup," "new"; 3 runs); sentence (e.g., "The cup is new and blue"; 2 runs); and phrase responses (e.g., "new blue cup"; 2 runs), respectively. Additionally, the orders of overt and covert sessions and those of the word, sentence, and

phrase tasks were counterbalanced. On each trial, a picture was presented for 2 sec, preceded by a fixation cross for 2 sec and followed by a 6-, 10-, or 14-sec inter-test interval, during which an asterisk was displayed. Each subject named the picture according to the single word, phrase, or sentence instructions given at the beginning of the run. Functional MR imaging data processing involved motion correction and the generation of activation maps for each condition by using cross-correlation of a reference waveform with the motion-corrected EPI data on a pixel-by-pixel basis (AFNI) (Cox, 1996). Data then were transformed into the Talairach Tournoux coordinate space and overlaid on the 3D high-resolution volume data. Results were merged such that for each of the two sessions for each participant, three datasets were created (single-word, sentence, and phrase).

RESULTS

Phrases yielded greater activity in a left inferior frontal region relative to single words, while the sentence vs single word comparison did not show this effect. Relative to covert responses, overt responses produced stronger activation in language-related areas (e.g., Broca's area, superior temporal gyrus) and additional activation in motor areas.

CONCLUSION

As anticipated, the phrase vs single word comparison yielded significant activation involving the left inferior frontal gyrus for both the covert and overt response conditions. The sentence vs single word comparison did not show this effect. Although the phrase vs sentence comparison did not show significant differences in left inferior frontal regions in either the overt or covert conditions, a marginally significant cluster ($p < 0.10$) was noted in the covert condition with deconvolution analysis and left inferior frontal gyrus designated a region of interest. Testing of additional participants is planned to increase statistical power.

KEY WORDS: Brain, functional MR imaging, memory

The authors of this work have indicated the following affiliations/disclosures: National Institutes of Health/NIDCD1 R21 DC005496: Principal investigator.

Paper 352 Starting at 9:04 AM, Ending at 9:12 AM

Combined Morphologic, Perfusional, and Functional MR Examination for the Presurgical Planning of Patients with Nonenhancing Brain Gliomas

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Chieti, ITALY

PURPOSE

This study aims to explore the possibility to obtain morphologic and functional data in a single MR session to predict tumor grade and tumor precise localization in respect to eloquent cortices.

MATERIALS & METHODS

Ten patients harboring nonenhancing space occupying lesions received morphologic MR imaging followed by functional (BOLDc) and perfusional evaluation in a single session. Perfusion imaging was acquired with a temporal

resolution of 1.9 seconds, 10 seconds after an intravenous bolus of contrast material (1.0 mol/L Gadobutrol, 5 mL/sec). Maps of CBV, CBF, MTT, and TTP were calculated. Functional MR imaging with BOLD technique was performed with a block paradigm alternating rest/control to task conditions. Motor and language functions were explored.

RESULTS

Patients complained during the MR study. MR imaging revealed nonenhancing lesions highly suspected for glioma. In 2 patients the CBV was increased in regions of the tumor showing anaplasia at histopathology. BOLDc fMRI during motor tasks revealed region of activation with a good somatotopical congruence while language tasks allowed lateralization of verbal functions.

CONCLUSION

The combination of three different MR studies in a single session is a practicable task which allows to obtain a global assesment of the location and perfusional status of the tumor as well as a precise cortical mapping.

KEY WORDS: fMRI, perfusion, brain tumors

Paper 353 Starting at 9:12 AM, Ending at 9:20 AM

The Use of MR Spectroscopy at Two Echo Times to Differentiate Toxoplasmosis from Central Nervous System Lymphoma in Immunocompromised Patients

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North Shore University Hospital
Manhasset, NY

PURPOSE

To examine the advantages of using MR spectroscopy (MRS) with long echo times (TE = 144 ms) along with short TE (30-35 ms) to distinguish central nervous system (CNS) toxoplasmosis from lymphoma in the immunocompromised patient.

MATERIALS & METHODS

Single-voxel MR spectra were acquired with both short and long TE to evaluate seven lesions in immunocompromised patients. Diagnoses of CNS toxoplasmosis and lymphoma were considered possible based on conventional MR imaging appearance and clinical presentation. Diagnosis was confirmed via direct pathologic correlation or response to treatment in all lesions evaluated.

RESULTS

At short TE all seven lesions had elevated lipid peaks at spectral positions of 1.2 parts per million (ppm) and 0.9 ppm. Only the two lymphoma spectra had a lactate signal appearing as a small spike or shoulder on the left side of the 1.2 ppm peak (Table 1). The 0.9 ppm lipid peak was smaller than the broad glutamate + glutamine (Glx) peak at 2.2 ppm in the lymphomas, and was comparable to or larger than the Glx peak in toxoplasmosis. At TE = 144 ms, all five toxoplasmosis lesions had an elevated lipid peak, while the two lymphomas did not. Both lymphoma spectra had a large choline peak at 3.2 ppm, and a negative lactate signal at 1.3 ppm which was absent from toxoplasmosis spectra. Our

observations are very similar to some published short-TE spectra (1), but differ from some earlier published reports (2-5).

CONCLUSION

At TE = 144 ms, a dominant lipid peak at 1.2 ppm strongly suggests toxoplasmosis and a dominant choline peak at 3.2 ppm strongly suggests lymphoma. In questionable cases, evidence of lactate, or a 0.9 ppm lipid peak that is smaller than the broad Glx peaks near 2.2 ppm at short TE, suggests lymphoma. Standard metabolite ratios of N-acetyl aspartate (NAA), creatine, and choline often are not helpful due to contamination with normal tissue in the MRS voxel.

Table 1. Spectral Comparison of Toxoplasmosis and Lymphoma.

	Lymphoma	Toxoplasmosis
TE = 30/35	Glx >= 0.9 ppm	0.9 ppm >= Glx
	Lactate shoulder	No lactate shoulder
TE = 144	Cho > 1.2 ppm	1.2 ppm > Cho
	Lactate (negative)	No lactate

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KEY WORDS: MR spectroscopy, toxoplasmosis, HIV

Paper 354 Starting at 9:20 AM, Ending at 9:28 AM

Proton MR Spectroscopy of Mesial Temporal Sclerosis: Analysis of Voxel Shape and Position to Improve Diagnostic Accuracy

Imbesi, S. G. • Niku, S.

University of California San Diego Medical Center
San Diego, CA

PURPOSE

To determine if change in voxel shape and position will improve the diagnostic accuracy of proton MR spectroscopy in patient evaluation for mesial temporal sclerosis.

MATERIALS & METHODS

In ten consecutive patients with the diagnosis of unilateral mesial temporal sclerosis on MR imaging and/or electroencephalography, proton MR spectroscopy was performed. Using a 1.5 T MR unit (Symphony, Siemens, Erlangen, Germany) and the standard PRESS protocol with long TE (144 msec), single voxel spectroscopy was obtained in the

right and left hippocampus and adjacent medial temporal lobes. First, the standard 2 x 2 x 2 cm (total volume 8 ml) cubic voxels were placed sequentially bilaterally and spectra generated. Then, 1 x 2 x 4 cm (total volume 8 ml) rectangular voxels were placed sequentially bilaterally and repeat spectra generated. For these elongated rectangular voxels, the dimensions were 1 cm superior-inferior, 2 cm medial-lateral, and 4 cm anterior-posterior. With this voxel shape, more of the entirety of the hippocampus and less of the adjacent medial temporal lobe brain parenchyma was included in the interrogation voxel. From each MR spectra, N-acetylaspartate to creatine (NAA/Cr) ratios and choline to creatine (Cho/Cr) ratios were obtained. The difference of NAA/Cr and Cho/Cr ratios between the affected and unaffected sides was calculated for each of the voxel types in each patient. Additionally, the mean difference and standard deviation also was calculated for each of the voxel types.

RESULTS

In all ten patients, the rectangular voxel correctly identified the abnormal side with a lower NAA/Cr ratio on the affected side compared to the unaffected side (predictive value = 100%). However, the cubic voxel only identified the abnormal side in six of the ten patients (predictive value = 60%). Additionally, the mean difference in NAA/Cr ratios between the affected and unaffected sides was 0.30 ($S_{n-1} = 0.17$) for the rectangular voxel but was 0.003 ($S_{n-1} = 0.26$) for the cubic voxel; that is, there was no overall significant difference in right and left NAA/Cr ratios when using the cubic voxel ($P = 0.007$). No significant correlation between the affected and unaffected sides was found using the Cho/Cr ratios.

CONCLUSION

Use of proton MR spectroscopy can be very helpful in the patient assessment of mesial temporal sclerosis. Confirmation of the abnormal side using electroencephalography, high-resolution coronal MR imaging, and now MR spectroscopy is critical prior to temporal lobe resection (1). Use of a 1 x 2 x 4 cm rectangular voxel places more of the hippocampus in the region of interrogation and results in less partial voluming artifact from the adjacent brain parenchyma which occurs with use of the standard 2 x 2 x 2 cm cubic voxel. While this sample size is small, use of the rectangular voxel appears to result in a much more accurate examination.

REFERENCES

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KEY WORDS: MR spectroscopy, mesial temporal sclerosis, voxel shape/position

Paper 355 Starting at 9:28 AM, Ending at 9:36 AM

New Techniques in Neuroradiology: Magnetoencephalography Offers Insight into Autism

Roberts, T. P. L.^{1,2,3} • Ferrari, P.¹ • Oram, J.¹ • Flagg, E.¹ • Gage, N.⁴ • Siegel, B.⁵ • Roberts, W.²

¹University of Toronto, Toronto, ON, CANADA, ²Hospital for Sick Children, Toronto, ON, CANADA, ³Toronto Western Research Institute, Toronto, ON, CANADA, ⁴University of California Irvine, Irvine, CA, ⁵University of California San Francisco, San Francisco, CA

PURPOSE

Many neurologic, psychiatric, and developmental disorders, in the absence of obvious structural lesions in the brain are relatively poorly served by conventional neuroradiology. However, emerging radiologic technologies such as magnetoencephalography (MEG) and its spatial analog, magnetic source imaging (MSI), well founded for presurgical localization of eloquent cortex, additionally allow a characterization of brain function in the time domain as well as in space. We applied state of the art MEG methodology to the study of children with autism spectrum disorder. A characteristic feature of autism is impairment of communication ability. One hypothesis is that this arises from an inability to process complex sounds and speech in auditory cortex and associated centers. Suggestion has been made that while processing may occur in typical anatomical substrates, the synchrony and timing of neuronal activity is disrupted, leading to impaired feature extraction, parsing, and processing of acoustic and language-related information.

MATERIALS & METHODS

We report on the use of magnetoencephalography to study auditory cortex of autistics, focusing on feature encoding in stimulus latency, language lateralization through late field activity and difference detection, as revealed by the mismatch negativity and its magnetic field, MMNm. These three measures rely on the millisecond temporal resolution of MEG, do not require subject compliance in task performance, and reveal activity at characteristic poststimulus times ranging from 100 ms to approximately 500 ms. Unlike functional MR imaging (fMRI), MEG is ideally suited to studies of temporal processing in auditory cortex and impairments of communication potentially arising from deficits at earlier stages of stimulus processing. We studied 30 children with autism (8-18 years) and age-matched controls, using tones, vowels, and consonant vowel (CV) combinations.

RESULTS

While in healthy controls, there is a pronounced impact of stimulus tone frequency on evoked response component latency, suggesting "frequency encoding" in the time domain, the frequency resolution of such stimulus tone encoding at and around the 100 ms response is compressed in autistics (especially in the RH, $D(100 \text{ Hz}-1 \text{ kHz}) = 17 \text{ ms}$ vs 35 ms (control), $p < 0.05$). Furthermore, processing (150-450 ms) of simple linguistic tokens tends to occur bilaterally in healthy developing children (as opposed to hemispherically lateralized in adults) but there is little activity evident in the RH of children with autism. Finally, phonetic feature differences (e.g. /a/ vs /u/) are associated with delayed (~350

ms poststimulus onset) “change detection responses”, or mismatch fields, MMF, in children with autism, compared to age-matched controls, ($D = 92$ ms, $p < 0.05$).

CONCLUSION

These findings can be interpreted as neural correlates of processing slowing and resolution degradation in autism and demonstrate the utility of MEG along with passive paradigms for the study of developmental disorders associated with language impairment. Techniques such as MEG which focus on temporal features of brain functional activity should be considered as useful adjuncts to spatial brain mapping techniques, such as fMRI, especially in the study of developmental language disorders.

KEY WORDS: Magnetoencephalography, autism, function

The authors of this work have indicated the following affiliations/disclosures: 1. National Alliance for Autism Research: Support of these studies; 2. Canadian Institutes of Health Research: Support of these studies; 3. UC MIND Institute: Support of these studies.

Friday Morning

8:00 AM - 9:36 AM

Room 606 - 609

**(65c) Interventional: General
(Scientific Papers 356 - 367)**

See also Parallel Sessions

(65a) Interventional: Aneurysms

(65b) Adult Brain: Functional Imaging (fMRI, MSI, MRS, PET)

(65d) Adult Brain: Vascular Imaging

Moderators: Glen K. Geremia, MD
Jacques E. Dion, MD

Paper 356 Starting at 8:00 AM, Ending at 8:08 AM

Improved Distal Distribution of N-Butyl Cyanoacrylate Glue by Simultaneous Injection of Five Percent Dextrose through the Guiding Catheter: Technical Note

Gailloud, P. • Heck, D. • Carpenter, J. • Moore, C. • Murphy, K.

The Johns Hopkins Medical Institutions
Baltimore, MD

PURPOSE

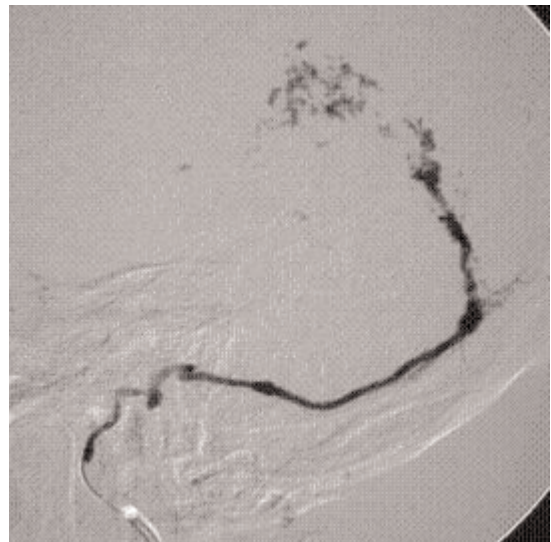
To report a simple new approach to the problem of distal n-butyl cyanoacrylate (n-BCA) glue distribution for cases in which the lesion itself cannot be reached by superselective catheterization, and which does not require wedging of the microcatheter.

MATERIALS & METHODS

The technique, which involves the injection of relatively large volumes of 5% dextrose (60 to 120 ml) through the guiding catheter concomitantly to the n-BCA injection through the microcatheter, is illustrated with four cases of posterior fossa DAVF in which a transvenous access was precluded by unfavorable venous anatomy.

RESULTS

Flooding the territory of the targeted vessel with 5% dextrose allows for deeper progression of the glue by delaying contact with ionic substances and subsequent polymerization. In our experience, n-BCA glue stopped progressing only when the dextrose injection was interrupted. Manual injection of the 5% dextrose with 60 ml syringes therefore provides excellent control on the extent of n-BCA penetration and distribution. At the same time, flooding the entire targeted arterial tree with 5% dextrose before and during n-BCA injection seems to prevent the occurrence of early polymerization observed with the wedged microcatheter technique. In each of the four reported DAVF cases, the n-BCA distribution matched the contrast agent distribution seen during superselective angiography. Figure 1 illustrates the injection of n-BCA in a posterior meningeal artery feeding a straight sinus DAVF: note the glue reaching the site of the fistula despite the extracranial location of the microcatheter tip.



CONCLUSION

We report our experience with a technique improving the distal progression of n-BCA glue in intricate arterial networks that cannot be superselectively catheterized, as it is often the case with DAVFs. In such an instance, the injection of 5% dextrose through the guiding catheter immediately before and during the superselective injection of n-BCA glue through the microcatheter optimizes the distal distribution of the adhesive agent.

KEY WORDS: NBCA glue, embolization, dural arteriovenous fistulas

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of N-BCA glue made by Cordis Neurovascular for embolization of DAVF.

The authors of this work have indicated the following affiliations/disclosures: Cordis Neurovascular: Consultant.

Paper 357 Starting at 8:08 AM, Ending at 8:16 AM

Endovascular Treatment of Carotid Cavernous Fistula Using a Combination of Metallic Stents and Platinum Coils

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Houston, TX

PURPOSE

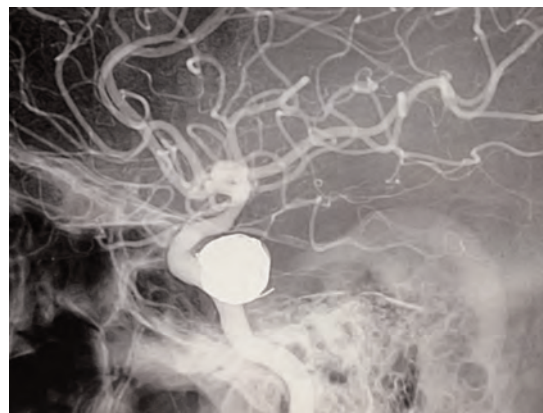
The ideal treatment for patients with carotid cavernous fistulas (CCF) is endovascular. Embolic materials that have been used for this purpose include: detachable balloons, platinum coils, fibred coils, and N-butylcyanoacrylate (NBCA). The ideal technique should preserve and reconstruct the parent artery while completely obliterating the fistula. We report our experience using a metallic stent in the carotid artery and platinum coils to occlude the fistula or the cavernous aneurysm responsible for the CCF.

MATERIALS & METHODS

This is a retrospective study of six patients presenting with direct (type A) CCF who were treated with stent deployment in the ICA combined with transarterial and/or transvenous obliteration of the fistula with platinum coils. In all six patients platinum coils (GDCs) were used as the embolic material and in two patients liquid adhesive also was used as an adjunct. In all patients, the parent artery was protected during the procedure with a nondetachable balloon. Access to the venous site of the fistula was achieved through a venous approach (4/6) or via a transarterial route (2/6).

RESULTS

In all six patients, the CCF was obliterated completely using this combined technique. The ICA was preserved in all 6 patients. The clinical outcome was excellent in all patients except for residual posttraumatic cranial nerve injury in one patient.



CONCLUSION

Combined endovascular techniques using a metallic stent to reconstruct the parent artery and embolic material (platinum coils) to obliterate the AV shunt can be used in the successful treatment of CCF while preserving the ICA.

KEY WORDS: Carotid cavernous fistula, metallic stent, embolization

Paper 358 Starting at 8:16 AM, Ending at 8:24 AM

Embolization of Cavernous Sinus Dural Arteriovenous Fistulae with Type IV Inferior Petrous Sinus

Liu, H. • Wang, Y. • Chen, Y. • Hsieh, H.

National Taiwan University Hospital
Taipei, TAIWAN REPUBLIC OF CHINA

PURPOSE

Inferior petrous sinus (IPS) approach is the first choice of treatment of cavernous dural AVF (CSAVF) in many centers. However, this approach depends on the status of IPS on the lesion side. Type IV IPS drainage means no direct communication between the IPS and internal jugular vein (bulb).

MATERIALS & METHODS

We report 22 cases of CSDAVF with type IV IPS that we encountered in the last 4 years. Sixteen cases were female and 5 were male. Their age ranged from 45 to 71 years. Sixteen cases had increased intracranial pressure and 3 cases had seizures attached.

RESULTS

They all had cortical drainage in the angiography study and ipsilateral type IV was noted in 13 cases and bilateral noted in 9 cases. All of the 13 cases with unilateral type IV drainage were treated successfully by contralateral IPS approach. In the 9 cases with bilateral type IV drainage, 1 was treated via the superior petrous sinus, 1 via the posterior condylar vein, 2 via the facial vein, 1 vein the contralateral facial vein, 1 via the paraspinal venous plexus, and 3 of them failed to be treated via transvenous approach. In these 3 cases, 1 was treated via the meningohypophyseal trunk, 2 via multiple transarterial approaching. All of them were treated successfully. One case suffered from transient 6th cranial nerve palsy.

CONCLUSION

The outcome of TVE for CSDVF is good and the complication rate is low. The success of TVE depends on the drainage status of the cavernous sinus. Transvenous approach is the treatment of choice for CSDAVF and if it is impossible to treated with TVE, transarterial approach is a very promising alternative treatment.

KEY WORDS: Arteriovenous fistula, dura, sinus, petrous sinus

Paper 359 Starting at 8:24 AM, Ending at 8:32 AM

Three-Dimensional Rotational Angiography Using the Propeller Rotation for the Evaluation of Intracranial Aneurysms

Gauvrit, J.¹ • Leclerc, X.¹ • Lubicz, B.¹ • Despretz, D.² • Lejeune, J.¹ • Pruvo, J.¹

¹Salengro Hospital, Lille, FRANCE, ²Philips Medical System, Suresnes, FRANCE

PURPOSE

Three-dimensional digital subtraction angiography (3D DSA) is used routinely for the evaluation of intracranial aneurysms. Technical progress including the "propeller rotation" recently has been achieved allowing larger range of rotation and faster rotational speed. Our purpose is to evaluate the potential advantages of this new technique for the assessment of intracranial aneurysms.

MATERIALS & METHODS

From November 2002 to March 2003, 23 patients with 24 aneurysms admitted for a subarachnoid haemorrhage (SAH) underwent 3D DSA with both standard and propeller rotations. The range of rotational angiographies extends over 180° for standard 3D DSA and 240° for propeller technique. Volume of 16 and 28 ml of contrast material was injected into the internal carotid artery or the vertebral artery for standard rotation vs 9 and 16 ml for propeller rotation. Both techniques have been compared for the assessment of aneurysm morphology and its relation to the neighboring vessels.

RESULTS

Overall image quality was optimal in all cases. Aneurysms were visualized and localized correctly by both techniques. A vessel incorporation into the neck was present in 10 cases including one that was judged poorly visualized by using the standard 3D DSA technique and accurately visualized by using the propeller rotation technique.

CONCLUSION

Three-dimensional DSA using the propeller rotation technique seems to be effective and allows to reduce the amount of contrast material related to the shortened acquisition time. In our series, the image quality was excellent in all cases with optimal anatomical information. This technique probably will replace the standard technique in the near future.

KEY WORDS: 3D DSA, aneurysms

The authors of this work have indicated the following affiliations/disclosures: Philips Medical Systems: Employee.

Paper 360 Starting at 8:32 AM, Ending at 8:40 AM

Serial Angiographic and Angioscopic Evaluation of Neointimal Changes after Aneurysm Treatment with Cerecyte Bioactive Coils in Dogs

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University of Miami
Miami, FL

PURPOSE

Neointimal thickness at the aneurysm neck is considered a good predictor of stable aneurysm coiling. It is difficult to evaluate neointimal thickness in the same group of animals: angiography is not sensitive enough; histology requires a terminal procedure so the same artery cannot be evaluated at multiple time points. Angioscopy provides direct visualization of tissue thickness covering metal structures. Visual estimates of tissue thickness can be performed after obtaining some experience using histopathologic comparison. Our goal was to evaluate changes of neointimal thickness at the aneurysm neck between 3 and 6 months post-embolization with Cerecyte bioactive coils (Micrus Corporation).

MATERIALS & METHODS

Five surgically created aneurysms were embolized with PGA-treated coils in three heparinized dogs. Packing density, neck remnant, coil protrusion, and parent vessel compromise were assessed with angiography immediately after coiling. Follow-up angiography and angioscopy was performed at 3 and 6 months. At 6 months the arteries were harvested and angioscopic results were compared to histology. Finally, neointimal thickness was assessed in a retrospective fashion based on the 3- and 6-month angioscopic recordings. Tissue thickness over platinum coils was estimated based on tissue opacity. No opacity (clear visualization of coils) means no tissue on the coils. Coils covered with tissue thicker than 250 microns cannot be seen. Between 0 and 250 micron the covering neointimal tissue causes gradual loss of visualization of coils.

RESULTS

All aneurysms featured wide neck that limited dense packing. Suboptimal packing was achieved in three, dense in two cases. Coil protrusion was seen in four, neck remnant in two cases. Radiopacity and mechanical properties felt similar to regular coils. At 3 months excellent endothelial coverage was observed even where wide gaps existed between coils. One aneurysm had a small proximal dog-ear, as evidenced by both angiography and angioscopy. A second aneurysm had a distal neck remnant, indicated by angioscopy only. No coil-compaction was observed. All protruding coils had thin endothelial coverage without causing lumen compromise. Histology revealed endothelial thickness between 176 and 488 microns at the aneurysm neck. When comparing 6 month findings to the 3-month results, coil protrusion and the neck remnants remained unchanged by 6 months. There was no significant difference in the neointimal thickness when evaluating the same areas as at 3 months.

CONCLUSION

Excellent endothelial coverage of the aneurysm neck was achieved using Cerecyte coils, without parent vessel compromise, as observed by histology and angiography at 6 months. These results provided the correlation between the two techniques allowing for neointimal thickness evaluation at intermediate time points. Based on these results it is concluded that, as observed by angiography, a thick neointimal layer was fully developed by 3 months.

KEY WORDS: Aneurysm, coil, bioactive

The authors of this work have indicated the following affiliations/disclosures: Micrus Corporation: Research support.

Paper 361 Starting at 8:40 AM, Ending at 8:48 AM

Covered Stents for the Treatment of Arteriovenous Fistulas and Pseudoaneurysms

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PURPOSE

To demonstrate that the covered stent is the best therapy option to preserve the parent vessel in traumatic vascular injury such as arteriovenous fistulas and pseudoaneurysms.

MATERIALS & METHODS

A total of 14 patients, 13 men and 1 woman, with ages between 15-58 years with traumatic vascular injury in head and neck were treated. These patients exhibited pseudoaneurysms located in the common carotid, cervical carotid, petrous carotid artery, and subclavian artery. The types of fistulas were vertebral arteriovenous, carotid-jugular and carotid cavernous. In the latter, success depends on location, the most complex being the ones located in segments 1 and 2 of the cavernous portion of the carotid.

RESULTS

Fourteen patients were treated with covered stent. No neurologic complications occurred as a result of covered stent deployment. All patients had follow-up examinations with standard angiography, performed at 3 to 36 months. In one patient neo intimal hyperplasia was documented at three months follow-up without restriction to the flow, 2 CCF were incomplete after stent deployment and it was necessary to complete the occlusion with histoacryl.

CONCLUSION

Covered stents are the best treatment option for pseudoaneurysms and arteriovenous fistulas because it allows preservation of the parent vessel. This technically has a greater complexity in segments 1 and 2 of the cavernous carotid artery because of the characteristics of the material and the anatomy of the siphon.

KEY WORDS: Covered stent, pseudoaneurysms, arteriovenous fistulas

Paper 362 Starting at 8:48 AM, Ending at 8:56 AM

Stenosis Following Suture-Mediated Arteriotomy Closure: Experience with the Perclose Device

Shownkeen, H. • Coleman, C. • Ortiz, C. • Hall, M.

Loyola University Medical Center
Maywood, IL

PURPOSE

Suture-mediated arteriotomy closure devices have been shown to be effective in postcatheter groin management compared to manual pressure. We describe our experience with the perclose arteriotomy closure device. We also look at the stenosis rate in patients who had multiple catheterizations, and repeat perclose management.

MATERIALS & METHODS

We reviewed 1330 femoral artery punctures performed from 08/10/99 to 12/05/03. Within this sample, 1114 puncture sites met the criteria for perclose attempt, and the remaining 216 were managed by direct pressure. Of the sites where perclose was attempted, hemostasis was achieved in 1040. Hemostasis was achieved by direct pressure in the remaining sites where perclose failed. There were 350 perclose attempts at sites where perclose had been done previously. Nineteen of the failed perclose attempts were at sites where there was prior perclose management. We compared the external iliac angiograms in the sites where there was previous perclose in to see if there was evidence of interval stenosis.

RESULTS

The overall perclose success rate 93% and the overall complication rate 0.4% when the perclose was successful (2 pseudoaneurysms, 1 infection, 1 hematoma). In the patients that had been perclosed previously had a 95% success rate and 0% complications. The complication rate was 5% (1 pseudoaneurysm, 2 hematomas, 1 excessive bleeding) in the group where perclose was attempted and failed, and 2% in the direct pressure group (1 pseudoaneurysm, 3 hematomas). We found a stenosis rate of less than 2% at arteriotomy sites in which a prior perclose procedure was performed, and none of these were hemodynamically significant with less than the 20% luminal compromise.

CONCLUSION

Suture mediated arteriotomy devices such as perclose are a safe way to manage arterial puncture postfemoral artery catheterization in patients for diagnostic and interventional patients. Approximately 30% percent of the patients were fully heparinized. Our experience is that repeat perclose use is also safe and effective.

KEY WORDS: Perclose, angiography, hemostasis

Paper 363 Starting at 8:56 AM, Ending at 9:04 AM**Mechanical Thrombectomy for Acute Stroke**

Versnick, E. J. • Marks, M. P. • Marcellus, M. L. • Do, H. M.
Stanford University
Stanford, CA

PURPOSE

Intraarterial thrombolysis has been shown to be of benefit in the treatment of acute ischemic strokes (1). However, recanalization rate, time to recanalization, and hemorrhagic complications may be improved with mechanical thrombectomy. This study evaluated the results using a protocol of primary thrombectomy for acute thromboembolic stroke.

MATERIALS & METHODS

All patients seen with anterior circulation strokes < 8 hours duration and postcirculation strokes < 12 hours duration were treated with this endovascular protocol during a 10-month period in 2003. Patients were excluded if they were candidates for IV tPA (0-3 hours). Treatment was with either the Concentric Retriever (Concentric Medical) or the Neuronet Retriever (Guidant Corp). Retrieval was augmented by low dose IA tPA (< 10 mg total dose) if revascularization was suboptimal. Outcome was measured using the NIHSS at presentation, 24 hours postprocedure, 5 days postprocedure/or time of discharge and at 1 month.

RESULTS

Ten patients were treated, six with anterior circulation strokes, three with posterior circulation strokes and one with embolic strokes involving both anterior and posterior circulations. Eight of ten (80%) were revascularized successfully (TIMI 3). The two patients not revascularized had posterior circulation strokes. One patient could not be treated due to proximal vessel tortuosity and one patient suffered a microwire perforation prior to complete revascularization. The Neuronet device was used in three and the Concentric Retriever device in five cases where successful revascularization occurred. Three cases required tPA (mean dose 9.7 mg) to aid revascularization. No patients had asymptomatic or symptomatic hemorrhages posttreatment. Mean time from onset of symptoms to initiation of procedure was 6 hours (5.3 hours for anterior circulation and 7.0 hours for posterior circulation). Time for recanalization from the start of the procedure was 0.2-1.8 hours for the six anterior circulation strokes (mean 1.17 ± 0.58). Only two of the posterior circulation strokes were revascularized in a mean procedure time of 2.75 ± 1.34 hours. The NIHSS at time of presentation was 9-42 (mean 25 ± 11.5). There were four deaths within 24 hours and an additional death at 48 hours. All 5 had posterior circulation strokes. The mean NIHSS at presentation in the patients that died was 34.8 ± 6.1 . The mean NIHSS at presentation in the surviving patients was 15.2 ± 4.5 . The mean NIHSS at 24 hours in the survivors was 9.0 ± 7.7 . The mean NIHSS at 5 days was 5.6 ± 7.2 . At 30 days the NIHSS was 3.0 ± 3.1 .

CONCLUSION

This preliminary experience suggests acute stroke treatment with mechanical thrombectomy may improve recanalization rates and time to recanalization compared to IA thrombolysis (1). These thrombectomy devices appear to revascularize

the anterior circulation more rapidly and completely. A larger randomized series of patients will be needed to establish efficacy of the therapeutic approach.

REFERENCES

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KEY WORDS: Ischemic stroke, thrombolysis

The authors of this work have indicated that they will be discussing/presenting and unapproved or investigative use of the Neuronet Retriever made by Guidant Corp. for thrombectomy.

Paper 364 Starting at 9:04 AM, Ending at 9:12 AM**Intracranial Angioplasty without Stenting for Symptomatic Atherosclerotic Stenosis: Long-Term Follow-Up**

Marks, M. P. • Marcellus, M. L. • Do, H. • Steinberg, G. K. • Tong, D. C. • Albers, G. W.

Stanford University
Stanford, CA

PURPOSE

Endovascular therapy for intracranial stenosis may be done using primary stenting or angioplasty alone. Proponents of stenting have suggested it may improve outcome and assist with complications such as dissection (1, 2). This study was undertaken to assess the efficacy and long-term outcome of angioplasty without stent placement for patients with symptomatic intracranial stenosis.

MATERIALS & METHODS

Thirty-six patients with thirty-seven symptomatic atherosclerotic intracranial stenosis underwent primary balloon angioplasty. All patients had symptoms despite medical therapy. Peri-procedural angiograms were assessed for pre and posttreatment stenosis and evidence of dissection. Thirty-four of 36 patients were available for follow-up ranging from 6-128 months. Mean follow-up was 52.9 months.

RESULTS

Mean pretreatment stenosis was 84.2% prior to angioplasty and was 43.3 % after angioplasty. The peri-procedural death and stroke rate (up to 30 days following procedure) was 8.3% (two deaths and one minor stroke). Two patients had strokes in the territory of angioplasty at 2 and 37 months postangioplasty. The annual stroke rate in the territory appropriate to the site of angioplasty was 3.36%. The annual stroke rate in the territory appropriate to the site of the angioplasty for those patients with a residual stenosis of $\geq 50\%$ (N = 18) was 3.00%. Patients with iatrogenic dissection (N = 11) did not have TIAs or strokes following treatment.

CONCLUSION

Long-term follow-up suggests that intracranial angioplasty reduces the risk of further stroke in symptomatic patients. Residual stenosis of $\geq 50\%$ or evidence of iatrogenic dissection at the time of angioplasty do not appear to confirm a higher risk of stroke in follow-up.

REFERENCES

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2. Mori T, Kazita K, Chokyu K, Mima T, Mori K. **Short-Term Arteriographic and Clinical Outcome after Cerebral Angioplasty and Stenting for Intracranial Vertebrobasilar and Carotid Atherosclerotic Occlusive Disease.** *AJNR Am J Neuroradiol* 2000;21:249-254

KEY WORDS: Angioplasty, stent, intracranial atherosclerosis

Paper 365 Starting at 9:12 AM, Ending at 9:20 AM

Intraarterial Thrombolysis for Stroke in Under 6 Hours: One Institution's Experience

Bourekas, E. C. • Slivka, A. P. • Shah, R. • Fetko, N. • Triola, C. • Kogut, M. • Christoforidis, G. A. • Mohammad, Y. • Slone, W.

The Ohio State University Medical Center
Columbus, OH

PURPOSE

Intraarterial (IA) thrombolysis has shown promise in the treatment of acute ischemic stroke. The PROACT II (Prolyse in Acute Cerebral Thromboembolism II) trial concluded that patients with middle cerebral artery occlusions treated with IA recombinant prourokinase (r-proUK) within 6 hours of the onset of acute stroke had significantly improved clinical outcome. Although the results of the trial did not lead to FDA approval of a specific drug, the results of this trial are considered convincing evidence by the American Society of Interventional and Therapeutic Neuroradiology (ASITN) and the Society of Interventional Radiology (SIR) that IA thrombolytic therapy is an acceptable and appropriate therapy for acute stroke. We prospectively treated patients with acute ischemic strokes within 6 hours of the onset of symptoms with intraarterial thrombolytics and report our institution's experience.

MATERIALS & METHODS

A total of 71 patients with angiographically demonstrated occlusions were treated with urokinase (25/71), rt-PA (43/71), or r-proUK (3/71) within 6 hours of stroke onset. The primary outcome was based on the percentage of patients with no or minimal neurologic disability at 30-90 days as indicated by a modified Rankin Scale (mRS) score of 0-2. Patients with prestroke disability, with a mRS of greater than 2, were considered to have a good outcome if there was no change in their mRS. Secondary outcomes included recanalization rates, frequency of intracranial hemorrhage with neurologic deterioration, and mortality.

RESULTS

The average age of the patients treated was 65 years (range 15-90 years) with 49% being females. The median admission National Institutes of Health Stroke Scale (NIHSS) score was 16. Fifty-four percent (34/64 patients, 8 lost to follow-up) of treated patients had a good outcome. The recanalization rate was 70%, with 44% demonstrating complete recanalization. The symptomatic intracranial hemorrhage rate was 8% (6/71) and mortality 14% (9/63).

CONCLUSION

Intraarterial thrombolysis performed within 6 hours of onset of symptoms of acute ischemic stroke can result in improved outcomes, high recanalization rates, low frequency of symptomatic intracranial hemorrhage and low mortality.

KEY WORDS: Thrombolysis, stroke, tissue plasminogen activator

Paper 366 Starting at 9:20 AM, Ending at 9:28 AM

Angiographic Collateral Scales for Intraarterial Thrombolysis

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¹University of Pennsylvania, Philadelphia, PA, ²University of California Los Angeles, Los Angeles, CA

PURPOSE

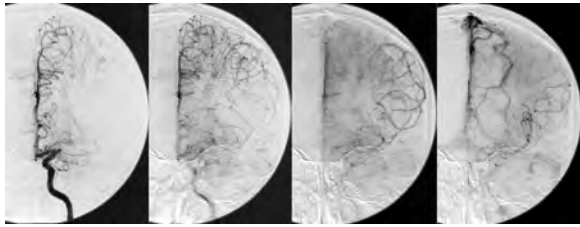
Collateral circulation is a critical determinant of outcome in acute ischemic stroke. Angiographic demonstration of leptomeningeal collaterals during intraarterial thrombolysis may be used for therapeutic and prognostic considerations. Numerous angiographic grading systems incorporate elements that assess the collateral circulation, employing different criteria that may vary with the site of vascular occlusion, corresponding collaterals, and available injections. We systematically evaluated all published or presented angiographic grading systems with respect to the collateral circulation in a consecutive case series of intraarterial thrombolysis.

MATERIALS & METHODS

All published or presented angiographic grading systems (n = 19) were used to score the extent of the collateral circulation on prethrombolysis injections of the affected territory in 58 cases (median age 65 years, range 18-93 years; 36:22 M:F) of intraarterial thrombolysis performed at a single center. A novel measure, the angiographic collateral ratio (ACR), compared arterial conduction times in ischemic and nonischemic regions. Angiographic scores were converted to numeric data with scale comparisons based on each vascular territory.

RESULTS

Prethrombolysis injections of the affected vascular territory were reviewed in occlusion of 18 M1 MCA segments, 9 M2 MCA segments, 11 ICA, 17 basilar arteries, 2 vertebral arteries, and 1 PCA. Including the novel angiographic collateral ratio, 19 scales were applicable in cases of M1 MCA occlusion, 18 in anterior M2 MCA occlusion, 14 in posterior M2 MCA occlusion, 19 in ICA occlusion, and 12 in vertebral or basilar occlusion. The angiographic grading systems included 5 binary scales and up to 8 scores per scale. The scales frequently were inapplicable due to inavailability of proximal injections that adequately depict all potential collateral sources. Frequent agreement was noted across scales in cases of poor or no collaterals, yet considerable discrepancy was noted when subtotal occlusion was present. Discriminant ability varied across scales, with limited application of binary scales. The ACR provided an objective numeric score that could be abstracted even when proximal injections were unavailable.



CONCLUSION

Angiographic grading systems for collateral circulation vary considerably. Angiographic collateral scales are dependent on the site of vessel occlusion, definition of the ischemic territory, consideration of potential collateral sources, and availability of proximal injections. The ACR, a quantitative ratio of arterial conduction times, may facilitate correlation of angiographic collaterals with ischemic markers on perfusion modalities.

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KEY WORDS: Collateral circulation, thrombolysis, stroke

Paper 367 Starting at 9:28 AM, Ending at 9:36 AM

Combination Treatment Fibrinolytics with Abciximab in Posterior Circulation Stroke: Pilot Study for Safety

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University of Washington
Seattle, WA

PURPOSE

Acute stroke due to occlusive vascular disease is a leading cause for morbidity and mortality. Current therapies for acute stroke include IV thrombolytic therapy or IA thrombolysis, within a therapeutic time window. There have been multiple studies describing benefits of adding GpIIb/IIIa inhibitor antiplatelet agents to thrombolytics in acute myocardial infarction. We undertook this study to evaluate the safety of GpIIb/IIIa inhibitor antiplatelet agents administered in conjunction with IA thrombolytics for acute stroke in the posterior circulation where outcomes traditionally have been poor despite optimal thrombolytic therapy.

MATERIALS & METHODS

Six patients who presented with acute posterior circulation stroke were admitted to the University of Washington Medical Center and Harborview Medical Center. Baseline neurologic evaluation was performed. All patients had significant neurologic impairment with locked in syndrome. These patients presented within 12 hours after onset of symptoms and underwent CT scans to rule out hemorrhage. One patient had a GDC coil embolization of an unruptured basilar tip aneurysm and presented with symptoms 3 hours

postprocedure. The patients underwent diagnostic cerebral angiograms. All patients had complete basilar occlusion and were treated with a combination of IA rtPA by superselective catheterization and IA Abciximab (Reopro). Heparin was used only in flush solutions. The patients underwent post-procedure CT scans to document hemorrhage, edema, and extent of infarcts.

RESULTS

There were no procedural complications. The postprocedure scans did not reveal any new hemorrhage or edema. One patient who had symptoms following GDC embolization of basilar tip aneurysm had complete recanalization of the basilar artery with complete resolutions of symptoms. The remaining patients all showed partial recanalization with no significant alteration in mental status.

CONCLUSION

The findings of this small pilot study show that adding GpIIb/IIIa inhibitor to thrombolytic therapy did not cause significant complications with any of the patients showing new hemorrhage or significant increase in edema. The only patient to present within 3 hours of symptoms showed complete resolution of symptoms. These results are encouraging and a larger study to demonstrate the risk of bleeding and evaluate clinical benefit of this combination treatment are warranted. The application of these regimens to the anterior circulation stroke also can be studied.

KEY WORDS: Stroke, thrombolysis, abciximab

Friday Morning

8:00 AM - 9:30 AM

Room 611 - 612

**(65d) Adult Brain: Vascular Imaging
(Scientific Papers 368 - 378)**

See also Parallel Sessions

(65a) *Interventional: Aneurysms*

(65b) *Adult Brain: Functional Imaging (fMRI, MSI, MRS, PET)*

(65c) *Interventional: General*

Moderators: Katie Dieu-Thu Vo, MD
John L. Go, MD

Paper 368 Starting at 8:00 AM, Ending at 8:08 AM**Improved Discrimination of High-Grade Carotid Stenoses with Supplemental Focused Axial Bolus Gadolinium MR Angiography**

Kaufmann, T. J. • Krecke, K. N. • Kallmes, D. F. • Huston, J.
Mayo Clinic
Rochester, MN

PURPOSE

Typical coronal bolus gadolinium MR angiography (MRA) techniques provide an excellent overview of the arterial vasculature in the neck. However, this technique does not provide adequate spatial resolution to accurately discriminate between luminal diameter stenoses greater than 50%, secondary to the slice thickness in the z-axis. We present a supplemental, focused, axial bolus gadolinium MRA sequence providing improved spatial resolution to more accurately represent high-grade carotid stenoses.

MATERIALS & METHODS

Our existing coronal bolus gadolinium MRA neck technique was modified to emphasize spatial resolution in the axial plane. One-half millimeter square pixel size, in the axial plane, was chosen in order to provide accurate characterization of a gadolinium-enhanced lumen as small as 1.0 mm diameter, based on the Nyquist Criteria for digital sampling. Iterative adjustments to sequence parameters were performed on 30 patients with suspected carotid occlusive disease to generate a robust pulse sequence meeting the goals for spatial and contrast resolution. Base parameters: 3D elliptical centric encoding, axial plane, 3D mode, NEX = 1, TE = minimum, flip angle = 45, bandwidth = 32, ZIP x 2, ZIP 512, gadolinium injection = 25 cc at 3 cc/sec.

RESULTS

Bolus gadolinium MRA parameters can be adjusted to improve spatial resolution in the axial plane from 1.5 mm to 0.5 mm thereby theoretically allowing accurate characterization of residual patent lumen from 3.0 mm to 1.0 mm diameter. Given average internal carotid luminal diameters in humans, this allows accurate discrimination of luminal diameter stenoses to 80% luminal diameter narrowing. Optimized parameters for axial acquisition: FOV = 25 cm, phase FOV = 0.5, freq. direction = R/L, slice thickness = 1 mm, slices = 70, matrix = 512 x 256, scan time 1:20, scan volume centered on stenosis in SI and AP planes. Bolus timing and gadolinium volume are copied from the coronal bolus MRA sequence.

CONCLUSION

A second bolus gadolinium MRA sequence, optimized for spatial and contrast resolution in the axial plane at the level of known stenosis, can characterize luminal diameter stenosis down to 80%, providing important discrimination of stenoses near the 70% NASCET criterion.

KEY WORDS: MR angiography, carotid stenosis

Paper 369 Starting at 8:08 AM, Ending at 8:16 AM**Reducing the Overestimation of Carotid Stenosis in Contrast-Enhanced MR Angiography: Flow Model Optimization with In Vivo Confirmation**

Vaid, R. • Rapp, J. H. • Saloner, D.
University of California San Francisco
San Francisco, CA

PURPOSE

Contrast-enhanced MR angiography (CE MRA) has been reported to overestimate the severity of carotid artery stenosis when compared to time-of-flight (TOF) MRA. The objectives of this study were to systematically investigate potential sources for this discrepancy and to optimize the parameters for CE MRA in vitro by using a carotid phantom flow paradigm. Finally, we sought to prospectively validate the in vitro findings by evaluating patients with known carotid disease using optimized MR parameters established by the carotid phantom studies.

MATERIALS & METHODS

A set of carotid phantoms with stenosis greater than 70% was employed for the in vitro studies. High resolution MR images of the lumen of carotid plaques excised en bloc were reproduced in acrylic by laser polymerization. Using a lost wax casting technique, silicone negative molds were created around wax reproductions of the acrylic lumen. The phantoms then were perfused with a glycerol and water mixture. Gadolinium was added for the CE MRA experiments in concentrations simulating physiologic conditions. Time-of-flight MRA was compared to CE MRA. Systematic alterations of various MR parameters allowed for assessment of the effects of differences in through-plane resolution, the time between injection of gadolinium and scan acquisition, and flow-related phenomenon (including the direction of the phase encoding gradient and the presence or absence of flow compensation) on CE MRA. The image appearance was compared also across different phantom geometries. Patients with known carotid stenosis then were evaluated to validate the findings established by the carotid phantom studies.

RESULTS

Degraded images were demonstrated when the frequency encoding gradient was applied along an axis parallel to the direction of flow. Standard implementation of CE MRA eliminates flow compensation and that was shown to contribute to image degradation. Marked improvement in image quality was demonstrated in flow models by orienting the frequency encoding gradient perpendicular to the direction of flow. This effect also was demonstrated clearly in patients with carotid stenosis. The model also was shown to corroborate numerous findings relating to CE MRA that have been reported in clinical studies including marked signal dropout in areas of stenosis when compared to TOF MRA, the detrimental effects of suboptimal delays between infusion of contrast media and scan acquisition, and the deterioration of the signal-to-noise ratio with increased through-plane resolution.

CONCLUSION

Contrast-enhanced MRA imaging using a carotid phantom flow paradigm demonstrates that several flow-related phenomena contribute to a loss of ability to accurately characterize the degree of luminal stenosis. In particular, orientation of the frequency encoding gradient is an important determinant of image quality, an effect validated in patients with carotid stenosis. Clearly, these parameters need to be taken into consideration if CE MRA is to be used in the assessment of carotid artery stenosis.

KEY WORDS: Carotid artery stenosis, contrast-enhanced MRA, carotid phantom model

Paper 370 Starting at 8:16 AM, Ending at 8:24 AM

Spontaneous Cervicocephalic Arterial Dissection in Older Adults

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PURPOSE

Spontaneous cervicocephalic arterial dissection is a common cause of stroke in young adults, yet this diagnosis is characterized poorly and rarely entertained in older individuals. We characterized spontaneous cervicocephalic arterial dissection in older adults to emphasize that dissection is a pathophysiologic mechanism that may be associated with vascular disease in all age groups.

MATERIALS & METHODS

Retrospective review of spontaneous cervicocephalic arterial dissection in individuals greater than 50 years old, with abstraction and analysis of clinical and radiographic data. Dissections were identified with CT angiography (CTA), axial fat-saturated T1-weighted MR imaging with MR angiography, or conventional angiography. We noted dissection location, multivessel involvement, and the presence of dissecting aneurysms. Parenchymal lesions and other angiographic findings were documented.

RESULTS

Spontaneous cervicocephalic arterial dissection was diagnosed in 50 cases (median age 58.8 years, range 50.6-79.8; 30 women, 20 men). Dissections were diagnosed initially with CTA in 9 cases, MR imaging/MR angiography in 27, and conventional angiography in 14. Carotid dissections occurred in 25/50 cases, with vertebral dissections in 26/50. Isolated dissections were noted in 40 cases, with 2 vessels dissected in 8, 3 vessels in 1, and 4 vessels in 1. Dissecting aneurysms were noted in only 18/50 cases. Fibromuscular dysplasia (FMD) was evident in 11/50 cases (median age 58.2, range 50.6-69.2; 8 women, 3 men). Atherosclerotic findings manifest as small vessel ischemic disease or angiographic lesions were observed in 30/50 cases (median age 64.7, range 54.2-79.8; 16 women, 14 men). Concomitant FMD and atherosclerosis occurred in 8/50 cases.

CONCLUSION

Spontaneous cervicocephalic arterial dissection may occur in older adults, possibly involving multiple vessels and frequently without evidence of a dissecting aneurysm. Atherosclerosis or FMD may be noted in the majority of cases. Atherosclerosis may be a predisposing factor for cervicocephalic arterial dissection.

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KEY WORDS: Dissection, atherosclerosis, age

Paper 371 Starting at 8:24 AM, Ending at 8:32 AM

Multislice CT Angiography in Diagnosing Vertebral Artery Dissection: Comparison with Catheter Angiography

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PURPOSE

To assess the sensitivity and specificity of a routine standardized multislice CT angiographic protocol for the detection of vertebral artery (VA) dissection.

MATERIALS & METHODS

Multislice CT angiograms of 17 patients with VA dissection and 17 control subjects were reviewed retrospectively. The acquisition protocol for multislice CT angiography was 1.25 mm nominal section thickness, a table speed of 7.5 mm per rotation (9.4 mm/sec), and a 0.8 second gantry rotation period. Maximum intensity projection and axial source images of the VAs were assessed by two radiologists. The sensitivity and specificity of multislice CT angiography in revealing VA dissection were determined.

RESULTS

Catheter angiography depicted 15 normal and 19 dissected VAs (including 5 stenotic-, 7 occlusive-, and 7 aneurysmal-type dissections) in the patient group and 28 normal and 6 atherosclerotic VAs in the control group. Multislice CT angiography enabled successful diagnosis of all (100%) of the 19 dissected VAs and 48 (98%) of the 49 nondissected VAs, but misplaced a severe atherosclerotic lesion as an aneurysmal-type dissection. The sensitivity, specificity, accuracy, positive and negative predictive values of multislice CT angiography in diagnosing VA dissection was 100 %, 98 %, 98.5 %, 95 %, and 100%, respectively.

CONCLUSION

In this series, multislice CT angiography was a sensitive and accurate technique for diagnosis of VA dissection.

KEY WORDS: CT angiography, dissection, vertebral artery

Paper 372 Starting at 8:32 AM, Ending at 8:40 AM**Comparison of Gadolinium-Enhanced MR Angiography with High Resolution Black Blood MR Imaging in Assessment of Carotid Artery Stenosis**

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PURPOSE

Atherosclerotic disease in the proximal internal carotid artery (ICA) and carotid bulb is a frequent source of stroke. The assessment of stroke risk from carotid atherosclerosis has relied on angiography, with surgical management indicated for symptomatic narrowing of 70% or more based on NASCET. Angiography does not represent accurately the plaque burden because of vascular remodeling that occurs during atherogenesis. This underestimation is exaggerated for bulb lesions, since the reference diameter for measuring stenosis may be larger than that at the point of narrowing. Our aim was to show that contrast-enhanced MR angiography (CE MRA) underestimates narrowing compared with high resolution black blood MR images (BB MRI), and that measurements of bulb stenosis by CE MRA correlate better with BB MRI when the common carotid artery (CCA) is used as the reference point rather than the distal ICA segment as advised by NASCET.

MATERIALS & METHODS

Twenty-four subjects (20 men and 4 women; age range, 57-83 years; mean age, 70.5 years $\pm$ 8.1 [SD]) with known carotid atherosclerosis underwent CE MRA and BB MRI. MR imaging was performed with a 1.5 T MR imager (GE Medical Systems, Milwaukee, WI) using a dual 3 inch phased-array surface coil. Black blood MR imaging was achieved by a electrocardiography-gated, double inversion-recovery, fast spin-echo sequence. A three-dimensional MR angiogram (CE MRA) was acquired at the arterial phase during administration of gadolinium (0.1 mmol/kg). Proton-density and postcontrast T1-weighted BB MRI images were acquired. MR angiograms were evaluated for degree of stenosis based on area and then on minimal diameter according to NASCET criteria by automated software (VesselMass; Leiden University). Patients with carotid bulb stenoses were evaluated also using CCA as the reference diameter. Outer wall and lumen contours were drawn on postcontrast T1-weighted BB MRI images at the point of the greatest narrowing using VesselMass software. Percent stenoses were compared with stenoses by CE MRA based on area and diameter measurements.

RESULTS

Percent stenosis based on CE MRA area measurements using NASCET criteria correlated with stenosis determined by BB MRI ($r = 0.77$; 95% CI: 0.58, 0.89). Black blood MR imaging values exceeded corresponding CE MRA measurements (0% stenosis by CE MRA corresponded to 63.1% [95% CI: 54.6, 71.6] by BB MRI). Seventy percent diameter stenosis by CE MRA corresponded to 89.4% (95% CI: 85.1, 93.6) by BB MRI. When the CCA was used as the reference diameter for cases with bulb stenosis ($n = 3$), the correlation with BB MRI measurements tended to be stronger ($r = 0.87$; 95% CI:

0.73, 0.94; $p = 0.14$ compared with $r = 0.77$); however, this did not effect the BB MRI stenosis measurement that corresponded with 70% diameter stenosis by CE MRA (89.7% [95% CI: 85.7, 93.7]).

CONCLUSION

Contrast-enhanced MR angiography underestimates the degree of luminal narrowing when compared to BB MRI, which measures the outer wall and therefore accounts for vascular remodeling. Therefore, BB MRI provides a more accurate assessment of plaque burden. Contrast-enhanced MR angiography tended to correlate better with BB MRI measurements when the CCA was used as the reference diameter for carotid bulb lesions rather than using stenoses based on NASCET criteria, suggesting this may help to correct the underestimation of stenosis.

KEY WORDS: Arteriosclerosis, carotid artery, stenosis or obstruction, MR imaging, vascular studies

Paper 373 Starting at 8:40 AM, Ending at 8:48 AM**MR Angiographic Evaluation of Platinum Coil Packs at 1.5 and 3.0 T: An In Vitro Assessment of Artifact Production**

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PURPOSE

The ISAT trial has provided data suggesting that in the appropriately selected population, aneurysm patients treated with endovascular therapy will have a superior outcome compared to those who undergo surgical clipping at 1 year. Despite the lack of long-term data regarding aneurysm recurrence and the existence of short-term data, which shows that coiled aneurysms can recur even after initial total occlusion, the number of aneurysms referred for endovascular evaluation and therapy is increasing. It follows that the number of patients who will require follow-up evaluation will increase. Although digital subtraction angiography (DSA) is the gold standard examination to evaluate the postcoiled aneurysm, recent reports have suggested that ultrashort echo time (TE) techniques can adequately decrease the susceptibility-induced artifact that has thus far limited the use of MRA. The purpose of this study was to examine the characteristics of platinum coil packs of different densities, with different TEs, and at two different field strengths (1.5 and 3.0 T). Multiple 3D TOF sequences and a contrast-enhanced (CE) MRA sequence were investigated.

MATERIALS & METHODS

Two aneurysm models were created from Word Bartholin Gland catheters and filled with TruFill DCS detachable coils, which resulted in the following coil pack densities (CPDs): 44.9% (Model 1) and 22.4% (Model 2). These models then were suspended in a Jell-O matrix and scanned at 1.5 and 3.0 T. On the 3D TOF sequences, the TE was decreased incrementally to reduce the amount of susceptibility-induced signal loss. A single CE True FISP MRA was performed. Absolute diameter measurements in three orthogonal planes and volume calculations were performed and overestimation

factors calculated. Statistical analysis was performed including Analysis of Variance and Protected Least Squares Difference post-hoc tests.

RESULTS

Susceptibility-induced signal loss was significantly greater at higher coil pack densities, longer TEs, and higher field strength. Signal loss decreased significantly with decreasing TE on 3D TOF sequences and was the least on the CE MRA sequence. There was no significant change in artifact for the CE MRA sequence at 1.5 and 3.0 or among the two CPDs. With 3D TOF techniques, significantly more artifact was created in the frequency-encoding direction compared to the other two dimensions.

CONCLUSION

At 1.5 T, short TE 3D TOF techniques and CE MRA produce the least amount of susceptibility-induced signal loss and can be used to assess the postcoil patient. At 3.0 T, any improvement gained from decreasing the TE on 3D TOF techniques is overwhelmed by the increase in susceptibility artifacts. CE MRA, however, does not result in a significant change in artifact compared to 1.5 T and can benefit from improved signal-to-noise, spatial and temporal resolution. Statistically more artifact was created in the frequency encoding direction and is related to its lower gradient strength. Aneurysm neck orientation relative to the frequency encoding gradient direction is therefore a critical consideration when prescribing an MRA sequence in this setting. Future developments in postcoiling MRA imaging should be focused on artifact reduction with 3D TOF techniques at 1.5 T and CE MRA techniques at 3.0 T.

KEY WORDS: MRA, aneurysm

Paper 374 Starting at 8:48 AM, Ending at 8:56 AM

Screening of Unruptured Intracranial Aneurysms with MR Angiography: Development of Novel Computer-Aided Detection System

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PURPOSE

MR angiography (MRA) without use of contrast media can detect noninvasively unruptured intracranial aneurysms with potential risk of rupture. However, it is difficult and time-consuming for radiologists to find small aneurysms, aneurysms overlapping with adjacent vessels, or aneurysms in unusual locations, on the maximum intensity projection (MIP) images of MRA. Our purpose is to develop an automated computerized scheme for detection of intracranial aneurysms based on the use of three-dimensional (3D) selective enhancement filters.

MATERIALS & METHODS

MR angiography studies of 60 patients for evaluation of possible intracranial vascular disease were acquired on a 1.5 T MR scanner by use of 3D time-of-flight technique. The MRA data base consisted of 29 abnormal cases with 36

aneurysms (effective diameter: 3-26 mm, mean of 6.6 mm) and 31 normal cases, where each MRA isotropic volume data was obtained from original data by use of a linear interpolation, and the data was 400 x 400 x 128 voxels with a voxel size of 0.5 mm. First, the isotropic 3D MRA images were processed by use of three selective, multiscale filters for the enhancement of aneurysms, vessels, and vessel walls. Second, a region for searching initial aneurysm candidates for each case was determined by a distance from the surface of main vessels. The initial candidates were identified by use of multiple gray-level thresholding on the dot-enhanced images. Third, candidate regions were segmented by use of a region growing technique with monitoring the changes of image features on size, shape, and gray level. Some false positives subsequently were removed by use of rules based on localized image features. Fourth, all candidates were classified into several types by size and local structures. Finally, the partial 3D images for a specific volume region were created automatically for radiologists' review to identify an aneurysm or a false positive.

RESULTS

With our CAD scheme, all aneurysms were detected correctly (sensitivity 100%) with 0.55 false positives per patient. The partial 3D images of each candidate were useful for assisting radiologists in identifying correct aneurysms.

CONCLUSION

Our CAD system would be useful in assisting radiologists for detection of intracranial aneurysms in MRA images.

KEY WORDS: Intracranial aneurysms, MR angiography, computer-aided diagnosis (CAD)

Paper 375 Starting at 8:56 AM, Ending at 9:04 AM

The Distal Dural Ring: A Radiologic and Microsurgical Study in Cadavers

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PURPOSE

To evaluate the efficacy of MR imaging in identifying the distal dural ring of the internal carotid artery (ICA). In 2003 we reported a study of 20 patients where MR imaging was successful in visualizing the distal dural ring and its intimate anatomical relationships. The aim of this cadaveric study was to develop a technique of imaging the distal dural ring to validate our original findings by direct anatomical comparison.

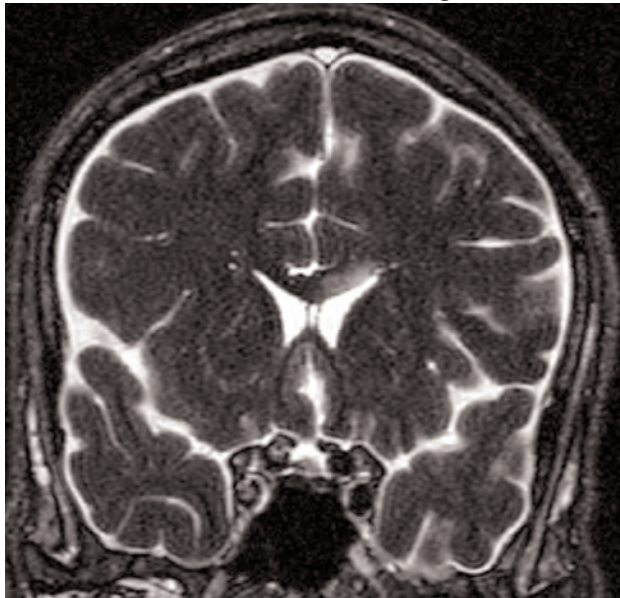
MATERIALS & METHODS

Fifteen cadavers comprised the study cohort. The following sequences were used: unenhanced thin slice coronal heavily T2-weighted, T2-weighted simulated flow using water and T1-weighted post ferrous oxide. All sequences were not performed on all cadavers. MR parameters were: fast spin echo, TR 5000 ms, TE 99 ms, FOV 24 x 18, 2 mm coronal slices with zero spacing, 384 x 256/4 NEX using a 1.5 T GE magnet. Source images were reformatted to 0.4 mm thickness and reviewed at a workstation to identify the distal dural ring on each side. All 15 cadavers were injected with colored

latex and underwent microsurgical dissection. The distal dural ring and its relationship to the ICA and surrounding anatomical structures was located using a surgical microscope and compared with the reformatted MR images.

RESULTS

The ferrous oxide enhanced images were successful in visualizing the distal ICA and its distal dural ring in 15 of 28 ICAs. Ferrous oxide was successful but caused minimal "blooming" of the vessels in 2 of 28 ICAs and was unsuccessful in 11 of 28 ICAs. Unenhanced T2-weighted images were successful in 21 of 26 ICAs, and was identified as the optimal imaging technique. Extravasation of contrast obscured the distal dural ring in 2 cadavers. Microsurgical dissection of the specimens demonstrated the intracranial anatomy and the relationship of the ICA and ophthalmic artery to the distal dural ring. Successful sequences correlated with the location of the distal dural ring at dissection.



CONCLUSION

Thin slice T2-weighted coronal MR imaging with reformatting is the optimal sequence for visualizing the distal dural ring and distal ICA. Clinical application of this sequence will assist the multidisciplinary management of distal ICA aneurysms.

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KEY WORDS: Distal dural ring, MR imaging, anatomical study

Paper 376 Starting at 9:04 AM, Ending at 9:12 AM

Titanium vs Nontitanium Aneurysm Clips at 1.5 and 3.0 T and the Effects of Decreasing the Echo Time: An In Vitro Assessment toward Noninvasive Imaging of the Postclip Aneurysm Patient

Tsai, J. • Walker, M. T. • Parrish, T. • Shaibani, A. • Tzung, B. • Krupinski, E. • Russell, E. J.

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PURPOSE

Open surgical clipping has been the mainstay of aneurysm therapy for decades and will be an integral component of the treatment algorithm for years to come. Digital subtraction angiography (DSA) is the gold standard exam to assess the postclip patient but carries a small risk of neurologic complication. Advances in noninvasive imaging such as MR angiography (MRA) are challenging the role of DSA in a variety of clinical scenarios. The postclip patient remains problematic because of susceptibility-induced artifact on MRA. The introduction of titanium clips positively impacted MRA imaging of aneurysm clips because of its improved artifact profile but nontitanium clips are still ubiquitous due to their physical properties. The introduction of higher field magnets provides an opportunity to investigate and optimize imaging protocols at different field strengths and aneurysm clip metallurgy. The purpose of this study was to investigate the differences in artifact production at 1.5 vs 3.0 T of titanium and nontitanium aneurysm clips and evaluate the effect of optimizing (decreasing) the echo time (TE) to decrease susceptibility-induced signal loss. Seven different 3-dimensional time of flight (3D TOF) and our standard contrast-enhanced (CE) MRA were studied.

MATERIALS & METHODS

A straight titanium (Sugita titanium alloy) and a straight nontitanium aneurysm clip (Sugita Elgiloy-cobalt alloy) of the same length were suspended in a Jell-O mold to mimic intracranial placement. Seven 3D TOF sequences and our standard CE True FISP MRA technique were performed at both 1.5 and 3.0 T. For the 3D TOF sequences, the echo time (TE), pixel bandwidth (BW), percent phase encode sampling, and flow compensation were changed incrementally and progressively to minimize the clip artifact. The True FISP sequence was run once. Artifact size was quantified by measuring the greatest diameter of both susceptibility-induced signal loss and adjacent signal displacement in two orthogonal planes relative to the tip of the aneurysm blades. Also, volumetric measurements of the entire clip-induced signal loss were quantified using an automated region growing segmentation algorithm. Statistical analysis was performed and the null hypothesis was rejected at $p < .05$.

RESULTS

The titanium clip produced significantly less artifact compared to the nontitanium clip with each sequence and at both field strengths. Artifacts were statistically improved with decreasing the TE on 3D TOF MRA. As expected, artifact was significantly less on the CE True FISP acquisitions.

CONCLUSION

Improved visualization of the perianeurysmal soft tissues in postclipped patients is best accomplished by short-TE, 3D TOF techniques at 1.5 T in patients with titanium clips. Scanning at higher field strengths does not provide incremental gain with 3D TOF techniques and in fact degrades image quality due to significant increases in susceptibility-induced artifacts. At 3.0 T, CE True FISP MRA techniques may provide the best opportunity for advancement of minimally invasive vascular imaging. As predicted, nontitanium clips produced significantly more artifact than titanium clips at both field strengths and may require DSA for accurate postoperative assessment.

KEY WORDS: MRA, aneurysm clips

Paper 377 Starting at 9:12 AM, Ending at 9:17 AM

Reversal of Carotid Sinus Syndrome Following Carotid Stenting: Possible Synergistic Mechanism

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PURPOSE

Hemodynamic disturbances that occur in relationship to carotid stenting are becoming increasingly recognized. Sustained hypotension with or without bradycardia may develop after carotid angioplasty and stent placement, which has been attributed primarily to carotid sinus dysfunction. We report on a patient with a severe carotid stenosis and proven preexisting carotid sinus syndrome which disappeared following carotid stenting. To our knowledge this is the first report of reversal of carotid sinus syndrome after carotid stenting.

MATERIALS & METHODS

A 49-year-old white male with a history of right pyriform sinus squamous cell carcinoma treated with radiation therapy 3 years ago presented with recurrent syncopal episodes followed by diaphoresis and loss of consciousness. Cardiac evaluation was negative. Duplex ultrasound of the carotid arteries demonstrated bilateral stenoses, > 75% on the right. CT of the neck showed local invasion by cancer of the left pyriform sinus carcinoma with level II nodes. A table tilt test confirmed the diagnosis of carotid sinus syndrome. Angiography confirmed a 90% right carotid stenosis with a large calcified ulcerated, and a 50% stenosis on the left with the carotid artery surrounded by cancer. Because of concern for impending left carotid blow-out syndrome, right carotid stent reconstruction was first offered to the patient prior to treating the left side. Two days after the right carotid stenting procedure, the patient experienced one last 5-minute episode of diaphoresis, headache, blood pressure drop to 77/57 and a heart rate of 68. One week later, the patient was discharged home and no further episodes of carotid sinus dysfunction were observed for the next 12 months.

RESULTS

The normal carotid sinus baroreceptor system traditionally has been thought of as a short term regulator of arterial pressure, but now is recognized to be predominantly involved in long-term arterial pressure control. The net effect of carotid

baroreceptor stretching is increased vagal tone and decreased sympathetic tone, which synergistically act to decrease heart rate and arterial tone, thus decreasing blood pressure. Carotid sinus syndrome (CSS) was first described as an exaggerated baroreceptor mediated reflex whereby carotid sinus massage results in bradycardia and/or hypotension in patients with a history of syncope or dizziness. Three subtypes of CSS have been described: cardioinhibitory, vasodepressor, and a mixed form. The pathogenesis of CSS remains poorly understood. It has been reported in elderly people with hypertension or carotid atherosclerosis, and with space-occupying lesions near the carotid bifurcation, such as primary neoplasms, lymph node enlargement, and abscesses, and after carotid stenting. Paradoxically, our patient's CSS disappeared after carotid stenting.

CONCLUSION

In this patient with long-standing right carotid stenosis, CSS corresponded temporally to the development of left neck cancer. Yet, relief followed right carotid stenting. This is the first case that suggests the possibility of a synergy between local effects (left neck cancer) and central effects (flow-limiting right carotid stenosis) triggering CSS. Improving right carotid flow may have reduced the tone in the neural pathways involved to a subthreshold level, thereby relieving clinically manifest CSS.

KEY WORDS: Carotid sinus syndrome, stent

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of a carotid stent made by Cordis/Johnson & Johnson.

Paper 378 Starting at 9:17 AM, Ending at 9:22 AM

Transverse Sinus Stenting as Treatment for Benign Intracranial Hypertension in Young Male

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Madison, WI

PURPOSE

Venous outlet obstruction has been reported recently as a potentially treatable etiology of benign intracranial hypertension (BIH). Small case series from the United Kingdom and Australia have been reported utilizing stents in the transverse sinuses for stenosis in BIH patients with favorable results. A series from the United States described that angioplasty and thrombolytics were ineffective in consistently alleviating symptoms in BIH patients. We describe an unusual case of a 15-year-old male who had symptoms and findings of BIH including headaches, diplopia (bilateral 6th nerve palsies), papilledema, and visual acuity deterioration, which resolved after stenting of a transverse sinus stenosis.

MATERIALS & METHODS

Cerebral venography was performed using MR imaging, CT, and conventional angiographic techniques. Pressure measurements were obtained across the bilateral transverse sinus stenoses through a microcatheter and pressure differentials of ~25 cm of water were obtained. The right transverse sinus was selected for therapy as it was slightly larger and drained the nondominant hemisphere. At a second procedure, a self-expanding 10 mm x 40 mm Cordis Precise stent was

deployed across the stenosis under systemic heparinization. The patient was maintained on aspirin and warfarin postoperatively.

RESULTS

The right transverse sinus was patent after primary stenting with no residual stenosis and the patient's visual symptoms and headaches completely resolved within 1 week. His diplopia, visual acuity, and papilledema resolution were documented by an independent neuroophthalmologist.

CONCLUSION

Venous outlet obstruction should be considered as a possible etiology in patients with BIH. If sinus stenosis is present with a significant pressure gradient, stenting may be a viable treatment option.

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KEY WORDS: Benign intracranial hypertension

Friday Morning

10:00 AM - 10:30 AM
Ballroom 6 A

**(66) Open Forum with the ELC Chair:
What Would You Like for the 2005
ELC?**

— Gregory L. Katzman, MD

Friday Morning

10:00 AM -11:30 AM
Ballroom 6 B/C

(67) Stroke (ASITN)

(67a) Devices Update

— Gary R. Duckwiler, MD

(67b) Current Imaging of Stroke

— J. Pablo Villablanca, MD

(67c) Thrombolysis Update

— Thomas A. Tomsick, MD

Moderators: John C. Chaloupka, MD
Jeffrey L. Sunshine, MD, PhD

Devices Update

Gary R. Duckwiler, MD

LEARNING OBJECTIVES

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

- 1) Evaluate the interventional techniques for acute stroke treatment
- 2) Distinguish and review the patient selection criteria for interventional treatment techniques in acute stroke

PRESENTATION SUMMARY

As of the writing of this summary, there are no FDA approved devices for the acute interventional treatment of stroke. Multiple devices have been used, either under the auspices of phase I IDEs or under off-label use. Promising technologies using laser, laser-acoustic coupling, ultrasound, clot aspiration, maceration, angioplasty, and snares all have been explored. However, the only devices currently in trials are the Concentric Clot Retrieval Device (CRD) and the Ekos ultrasound thrombolytic infusion catheter. A review of these devices and an in-depth analysis of the CRD Phase I-II will be presented. By the time of the presentation, the CRD will have undergone an FDA review for approval.

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Current Imaging of Stroke

J. Pablo Villablanca, MD

LEARNING OBJECTIVES

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

- 1) To utilize CT and MR angiographic, diffusion and perfusion techniques to:
- 2) Distinguish the vascular etiology of a neurologic deficit
- 3) Assess reversibility and eligibility for acute therapies
- 4) Differentiate between tissue ischemia and stroke mimics
- 5) Utilize CT and MR to discriminate hemorrhagic from ischemic stroke

PRESENTATION SUMMARY

The role of multimodal CT and MR techniques in the evaluation of acute stroke will be examined. The ability of these modalities to provide information about the presence, location, and vascular territory of an ischemic lesion, the state of cerebral perfusion and tissue viability, and the status of the cervicocranial vasculature will be illustrated using a case-based presentation approach. The value of multimodal CT including routine CT, CT angiography (CTA) and quantitative CT perfusion (CTP) will be evaluated, including the

ability and reliability of CT to serve as a screening tool to identify early infarct signs, exclude hemorrhage and non-ischemic causes of acute neurologic deficits. The role of CTA to provide rapid and minimally invasive information about the presence and cause of arterial stenoses or occlusions will be illustrated. The ability of CTP to provide information about size, location, and severity of cerebral ischemia, cerebrovascular reserve, tissue at risk, and possibly thresholds of ischemia and the status of collateral circulation will be reviewed. The added value of MR imaging to identify the location and size of ischemia within minutes of symptom onset using diffusion weighted imaging (DWI) will be emphasized, including an examination of the transient ischemic event (TIA) population. The ability of relative perfusion MR (PWI) to identify all of the tissue at risk of infarction if vessel recanalization does not occur will be demonstrated. The ability to visualize the ischemic penumbra (the zone of perfusion, but not diffusion abnormality) in real time, and the opportunity to tailor treatment decisions based on individual patient hemodynamics and pathophysiology will be illustrated. The emerging application of gradient echo (GRE) sequences in the detection of microbleeds, and their significance in the thrombolysis population will be examined. The role of both time-of-flight (TOF MRA) and dynamic contrast-enhanced MRA (CE MRA) in the identification of stenosed or occluded large and medium sized cerebral vessels will be reviewed. Emphasis will be placed on the manner in which this information is being used not only to select the best candidates for treatment, but also to potentially extend the traditional therapeutic window, and to guide both acute and long-term treatment decisions. The utilization of these techniques, in isolation or combination, is influenced by a number of factors, including availability, ease of data acquisition and postprocessing requirements, patient risks, and cost. Finally, the relative advantages and disadvantages of each modality will be summarized briefly.

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Thrombolysis Update

Thomas A. Tomsick, MD

Disclosure: The author of this presentation has indicated the following affiliations/disclosures: 1. Genentech: Research grant; 2. Cordis Neurovascular, Inc.: Consulting fees.

The author of the presentation has indicated that he will be discussing/presenting an unapproved/investigative use of Altipase in intraarterial infusion and Abciximab in infusion for stroke. Altipase is made by Genentech and Abciximab is made by Centocor, Inc.

Friday Morning**10:30 AM - 11:00 AM****Room 611 - 612**

(67A) National Library of Medicine
(NLM): MEDLINE^{plus} Short
Demonstration

— *Gail Kouame*

Friday Morning**11:30 AM - 11:45 AM****Ballroom 6 B/C**

Closing Remarks

— *Victor M. Haughton, MD, ASNR President*

Notes

NOTE ABOUT SCANNED IMAGES: Scanned images are included in the proceedings book. Some submitted images were reduced during the printing process, thereby decreasing clarity. The images as originally submitted can be viewed within the abstract on the ASNR website at www.asnr.org/2004.

Scientific Posters 1-185

Exhibit Hall 4B (Level 4)

Monday, June 7

6:00 PM – 9:00 PM

Tuesday, June 8 - Thursday, June 10

6:30 AM - 9:00 PM

Friday, June 11

6:30 AM – 11:45 AM

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

Adult Brain
1-93

Poster 1

Effect of Postischemic Hyperemia on Ischemic Brain Tissue: Perfusion MR Evaluation with Transient Focal Cerebral Ischemia in Cats

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PURPOSE

To evaluate the effect of postischemic hyperemia on ischemic brain tissue in cases of hyperacute stroke by evaluating the regional cerebral blood volume (rCBV) of the reversible ischemia occurring in the transient focal cerebral ischemia in cats.

MATERIALS & METHODS

Seven adult Korean cats weighing 3-3.5 kg were used. The occluded artery was reperfused after temporary occlusion of the middle cerebral artery for 60 minutes. Both diffusion-weighted images (DWI) and perfusion-weighted images (PWI) were obtained at 1, 3, and 24 hours after reperfusion. The rCBV images were reconstructed from the PWI. The cats were killed after the 24-hour imaging. Brain slices were obtained and triphenyl tetrazolium chloride (TTC) staining was performed. The reversible ischemia was defined as occurring in the area of normalized high signal intensity on

follow-up DWI and normal staining on TTC stain. The DrCBV_{3hr-24hr} was defined as the difference between the rCBV ratios at 3 and 24 hours after reperfusion: $\text{DrCBV}_{3\text{hr-24hr}} = [|\text{rCBV}_{3\text{hr}} - \text{rCBV}_{24\text{hr}}| / \text{rCBV}_{\text{higher}}] \times 100$.

RESULTS

The periods of the increased rCBV varied in each cat. A reversible ischemic area demonstrating the period of increased rCBV during the 24 hours after reperfusion was evident in all 7 cats. Cat 1 showed severely increased rCBV values in the reversible ischemia and infarct at both 1 and 3 hours after reperfusion. At 24 hours after reperfusion, rCBV was decreased abruptly in the reversible ischemia. Cat 5 showed persistently decreased rCBV in the infarct throughout the observation period; but, postischemic hyperemia was observed at 24 hours after reperfusion in the reversible ischemia of this cat. The rCBV values at 1, 3, and 24 hours after reperfusion showed no statistically significant difference between the reversible ischemia and the infarct (reversible ischemia: 1.28 ± 0.34 , infarct: 1.10 ± 0.42). In the infarct, postischemic hyperemia was observed at various times and to various degrees after reperfusion. However the DrCBV_{3hr-24hr} of the reversible ischemia and the infarct differed from other to a statistically significant degree ($p = 0.018$). DrCBV_{3hr-24hr} of the reversible ischemia was above 27% in all cats (sensitivity: 100%, specificity: 71%).

CONCLUSION

Postischemic hyperemia was more dynamic in the reversible ischemia than in the infarct. This suggests that postischemic hyperemia does not represent a harmful phenomenon for hyperacute ischemic tissue in cases of early recanalization.

KEY WORDS: Stroke, perfusion MR

Poster 2

Three-Dimensional White Matter Tractography with Diffusion-Tensor Analysis and Fiber Tracking for Evaluation of Corticospinal Tract Injury with Acute Deep Intracerebral Hemorrhage

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PURPOSE

Three-dimensional white matter tractography with diffusion-tensor MR analysis and fiber tracking can be used to depict the main white matter tract anatomy, such as of the corticospinal tract. Seventy percent of intracerebral hemorrhages (ICH) occur in the putamen or thalamus, that is in the deep gray matter. A common symptom of putaminal or thalamic hemorrhage is hemiparesis that results in impaired motor

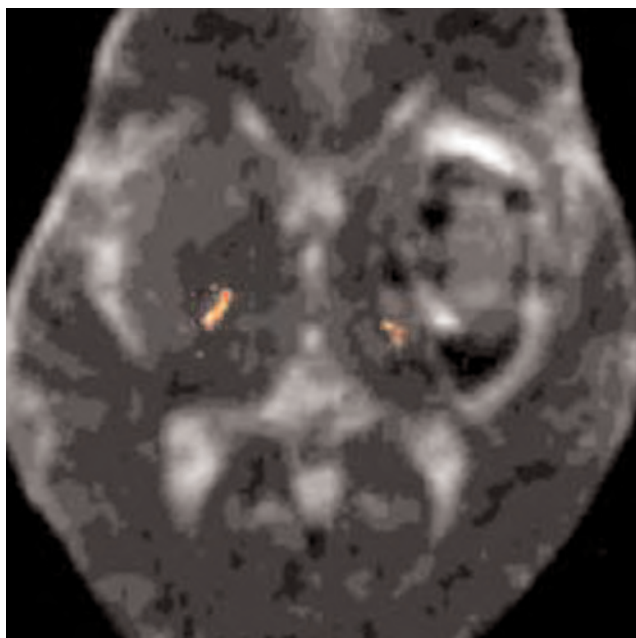
function. Such impairment in patients with deep ICH may be caused by corticospinal tract injury. Perihematomal tissue injury can be seen on diffusion-weighted MR images. Our goal was to assess the usefulness of three-dimensional white matter tractography for predicting functional motor outcome in patients with acute deep ICH.

MATERIALS & METHODS

Study subjects were 35 who underwent MR study within 72 hours after onset of putaminal or thalamic hemorrhage. Diffusion tensor images were obtained with a 1.5 T MR scanner (Magnetom Vision, Siemens Medical System, Erlangen, Germany). An echo-planar imaging was used, with diffusion gradient applied in six directions and a maximum b value of 1000 s/mm². Softwares (Volume one and dTV) downloaded from the internet [<http://www.volume-one.org/>][<http://www.ut-radiology.umin.jp/people/masutani/dTV.htm>] were used for diffusion tensor analysis and fiber tracking. We were able to depict corticospinal tracts that passed both the cerebral peduncle and precentral gyrus. In patients in which the corticospinal tract ipsilateral to the ICH side was depicted, we set separate regions of interest (ROI) at three levels bilaterally along the corticospinal tract and obtained apparent diffusion coefficient (ADC). We calculated the minimum ADC ratio between the ICH and the contralateral side among ROIs at each of the three levels. Depiction of the corticospinal tract and ADC were analyzed in association with functional motor outcome according to the NIH Stroke Scale scores at 4 weeks onset.

RESULTS

The corticospinal tract ipsilateral to the ICH was not depicted in 11 patients, all of whom had a poor outcome at 4 weeks. In all cases, the corticospinal tract contralateral to the ICH was depicted. In all cases in which the ipsilateral corticospinal tract was depicted, there was an adequate displacement of the tract, which was attributed to the ICH (Figure 1).



The ADC ratios of patients with an NIH Stroke Scale of 3 or 4 were significantly lower than the ADC ratios of patients with a good outcome.

CONCLUSION

Our findings indicate that three-dimensional white matter tractography with diffusion tensor MR analysis and fiber tracking is useful for predicting functional motor outcome in patients with deep ICH.

KEY WORDS: Fiber tracking, diffusion-tensor imaging, intracerebral hemorrhage

Poster 3

Effect of Skull Volume and Density on Differentiating Gray and White Matter on Routine CT Scans of the Brain

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PURPOSE

It is often difficult to diagnose early ischemic brain injury by CT and thus reliance often is placed upon subtle loss of the normal gray-white matter differentiation for its detection. Increased volume and density of the skull may compound the problem by diminishing the gray-white matter attenuation difference. The purpose of this investigation was then to examine the effects of skull volume and bone density on gray-white matter differentiation.

MATERIALS & METHODS

Patients were selected retrospectively as a thick/dense skull group based upon the subjective CT appearance of the calvarium. These patients had been diagnosed with thickened bone secondary to anemia, hyperostosis frontalis interna, renal disease, and long-term antiepileptic therapy. A total of 21 patients (4 men, 17 women; mean age, 49 years; age range, 21-84 years) with thick calvaria were compared with a control group of 22 patients whose brain CT had been interpreted as normal (6 men, 16 women; mean age, 32 years; age range, 22-49 years). Images were acquired helically at 10 mm intervals, 140 mA, and 140 kV. Three contiguous transaxial slices that included the basal ganglia on at least one image were evaluated for bone volume and density on a separate workstation using standard image analysis software (GE Advantage, Vxtool 3.0.26i). Patients were excluded at analysis if pertinent slices contained pneumatized bone. Attenuation values in Hounsfield units (HU) were obtained for the putamen, and frontal gray and white matter in both brain halves. Calvarial bone volumes, attenuation differences between white and gray matter, and mean pixel values for each slice, was compared between the thick skull and control groups using the Student's t-test.

RESULTS

The mean slice volumes in the thick skull group were 55.7, 54.3, 56 cc, compared with those in the normal group that were, respectively, 39.3, 38.5, and 39.9 cc, ($p < 0.001$) representing an overall 41% excess volume. The mean pixel value in the thick/dense group was 936 and 987 in the control group, an insignificant difference in bone density. The mean attenuation difference between right side white and gray matter was 5.48 HU for the thick/dense group and was 11.61 HU for the control group ($p < 0.0001$). Similarly, the mean attenuation difference between left side white and gray

matter was 5.17 HU for the thick/dense group and was 11.14 HU for the control group ($p < 0.0001$). There was no statistically significant difference between right and left sides within the same control and thick/dense groups.

CONCLUSION

Patients with a relatively thick calvarium demonstrated significantly diminished difference in the attenuation of gray and white matter. Therefore, gray-white matter discrimination in subjects with a thicker calvarium is comparatively more difficult, and likely makes ischemia in these patients more difficult to detect. Possible solutions include increasing the kV or mA to exaggerate gray-white matter attenuation difference or performing MR imaging when possible.

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KEY WORDS: Stroke, skull, CT methods

Poster 4

Low Cerebral Blood Flow Values Do Not always Indicate Decreased Cerebral Blood Flow

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PURPOSE

When constructing cerebral perfusion maps using "CT Perfusion 2" software, areas of low CBF and prolonged MTT which do not infarct are often seen. We systematically investigate this paradox and identify the reason for lack of infarction, despite the presence of abnormally low CBF and prolonged MTT values.

MATERIALS & METHODS

Retrospective analysis was performed in patients who presented to the emergency room with symptoms of acute stroke and who underwent a multislice CT perfusion study. Included patients were those who developed an infarction within the 2 cm CT perfusion acquisition volume, who did not move during imaging, and who had a visible deficit on CBF maps that was clearly larger than the final infarct by at least one third of a vascular territory. Out of 156 consecutive patients, 12 fulfilled these criteria and were analyzed. We performed region of interest (ROI) analysis within an area that did infarct (ROI1) and within a low CBF area that did not infarct (ROI3). Contralateral controls for both regions were analyzed, ROI2 and ROI4, respectively. For each ROI, the enhancement curve peak height (minus baseline) was determined using the cine data. Cerebral blood volume, MTT and CBF values for each ROI were generated using "CT Perfusion 2" software (GE Medical Systems, Milwaukee, WI). Ipsi and contralateral data were compared statistically using a paired t-test.

RESULTS

The average enhancement curve peak height of ROI1 (infarct) is 37% of its control ROI2 and is significantly different ($p < 0.0001$). The average enhancement peak of ROI3 (low CBF, no infarct) is equal to its control ROI4 and is not significantly different ($p > 0.4$). The average ROI1 CBV is 49% of its control and is significantly different ($p < 0.0001$). The average ROI3 CBV is 97% of its control and is not significantly different ($p > 0.2$). The average ROI1 and ROI3 MTT were 3.64 and 3.73 times larger than their respective controls and both significantly different ($p < 0.0001$) from their controls. The average ROI1 and ROI3 CBF were 19% and 32% of their respective controls and both significantly different ($p < 0.0001$) from their controls. It should be noted that visually, in all patients, the CBV lesion matched the final infarct, and the MTT "lesion" was identical to the CBF "lesion" and neither matched the final infarct.

Average ratio (+/- Standard deviation) of ROI1/2 & ROI3/4

Ratio	ROI1/ROI2	St.Dev	ROI3/ROI4	St. Dev
peak height	0.37	+/- 0.10	1.00	+/- 0.16
CB	0.49	+/-0.08	0.97	+/- 0.12
MTT	3.64	+/-1.27	3.73	+/- 1.17
CBF	0.19 +/-	0.08	0.32	+/- 0.12

CONCLUSION

In regions of low CBF, prolonged MTT and no infarct, we measured normal peak enhancement and normal CBV indicating a normal amount of blood delivery. Thus, a low CBF in the presence of normal peak enhancement, normal CBV and prolonged MTT appears to be an artifact in generating CBF maps. To avoid possible overestimation of "tissue at risk" of infarction, interpretation must be performed with an understanding of the underlying pathophysiology of infarction and the limitations of the tools used.

KEY WORDS: Perfusion, stroke, CT

Poster 5

Comparing Perfusion Measurements Using Singular Value Decomposition and Maximum Likelihood Expectation Maximization

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PURPOSE

To compare perfusion measurements based on maximum likelihood expectation maximization (MLEM), singular value decomposition (SVD), as well as SVD with block circulant and minimization of oscillations (oSVD) (1-3). Each method was compared to reference perfusion data obtained by positron emission tomography (PET).

MATERIALS & METHODS

We retrospectively analyzed MR and PET perfusion data obtained from seven patients of the St. Louis Carotid Occlusion Study (4). These patients with chronic, stable, carotid artery occlusions had MR and PET perfusion studies performed on the same day. MR data were collected on a

Siemens Magnetom Vision using EPI with power injection of gadodiamide dosed to 0.2 mmol/kg. Bolus passages were deconvolved using the methods of Vonken, et al. (1), Ostergaard, et al. (2), and Wu, et al (3). So as to maintain temporal causality for SVD, artificial time delays were added between arterial inputs and regions of interest (ROIs). This was done equally for all deconvolution methods. The processed results then were compared directly against PET results obtained by the Kety auto-radiographic method and the cerebral blood flow (CBF) corrections of Herscovitch, et al. (5). PET perfusion measurements were made on an ECAT EXACT HR scanner using boluses of [^{15}O]-H $_2$ O. For statistical analysis, MR pixels were binned in 6 mm x 6 mm x 6 mm volumes to match 6 mm three-dimensional Gaussian filtering used in PET processing. Arterial pixels were excluded from analyses. For each patient, MR CBF values from white matter ROIs were scaled to match PET CBF values from the same ROIs.

RESULTS

Perfusion processing by oSVD or SVD, when compared to PET, yielded more favorable Pearson correlations, Spearman rank correlations, and χ^2 values. For patient four, who suffered abnormally elevated ipsilateral vascular mean transit time, MLEM provided stronger associations with PET. However, other patients with elevated vMTT did not similarly benefit from evaluation by MLEM. The absolute number of sampled ROIs is shown.

		pt1	pt2	pt3	pt4	pt5	pt6	pt7
Pearson's R	MLEM	0.393	0.429	0.642	0.609	0.683	0.670	0.592
	SVD	0.416	0.449	0.647	0.549	0.740	0.706	0.500
	oSVD	0.419	0.434	0.656	0.586	0.713	0.713	0.602
chi2/N	MLEM	97.0	122.2	73.0	70.6	76.1	77.9	61.8
	SVD	95.0	119.5	72.2	78.4	64.6	70.9	71.5
	oSVD	94.6	121.5	70.7	73.7	70.2	69.4	60.7
N(ROIs)		1559	394	986	1426	879	519	792

CONCLUSION

For six of seven patients with chronic carotid artery occlusion, MR CBF determined using SVD or oSVD had stronger associations with PET results. The benefit of using SVD or oSVD over MLEM was significant with respect to number of chosen ROIs for a given patient; however, results did not generalize across patients.

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KEY WORDS: Perfusion, MR imaging, PET

The authors of this work have indicated the following affiliations/disclosures: 1. The NER Foundation: Fellowship in Cerebrovascular Disease Research; 2. Boston Scientific: Financial support.

Poster 6

Deoxygenation of Leptomeningeal Collaterals in Moyamoya Syndrome

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PURPOSE

Leptomeningeal collateral vessels sustain cerebral perfusion in the setting of moyamoya syndrome. The anatomical constraints associated with proximal arterial occlusion may increase longitudinal oxygen gradients and precapillary oxygen loss. We characterized the MR appearance of leptomeningeal collaterals in moyamoya syndrome and correlated slow flow in these circuitous collaterals with the presence of deoxygenation observed on gradient-echo T2*-weighted sequences.

MATERIALS & METHODS

Retrospective review of MR studies acquired in 24 cases (median age 35 years, range 19-67 years; 8:16 M:F) of moyamoya syndrome. Slow flow in leptomeningeal collaterals was identified as flow-related enhancement on FLAIR sequences. The presence of deoxygenation in these vascular segments was assessed on gradient-echo T2*-weighted sequences.

RESULTS

FLAIR vascular hyperintensities (FVH) were observed in 21/24 (88%) cases. These FVH were noted over bilateral convexities in 11/15 (73%) cases with bilateral proximal arterial stenoses. FVH were typically situated in the peri-sylvian region and fronto-parietal cortices. FVH were located predominantly adjacent to noninfarcted tissue, as most infarcts were deep, subcortical lesions in lenticulostriate territory (15/24 cases). Gradient-echo T2*-weighted hypointensity of leptomeningeal collaterals was noted in 17/21 (81%) cases with FVH. The extent of T2*-weighted hypointensity in leptomeningeal collaterals was limited with respect to the extent of the FVH. A gradation in the degree of T2*-weighted hypointensity was not observed.

CONCLUSION

MR imaging may reveal subtle features of leptomeningeal collaterals in moyamoya syndrome. Slow flow in these vascular segments may be apparent as FVH, with corresponding T2*-weighted hypointensity suggesting intravascular deoxygenation and the presence of a longitudinal oxygen gradient.

REFERENCES

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KEY WORDS: Moyamoya, deoxygenation, collateral circulation

Poster 7

Imaging of Intracranial Atherosclerotic Disease in Symptomatic Patients: A Comparison of Cerebral Digital Subtraction Angiography with MR Angiography

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PURPOSE

To determine the sensitivity and specificity of MRA for the detection of intracranial stenosis in patients presenting with an ischemic stroke or a transient ischemic attack (TIA) and to determine the relationship between intracranial stenosis and stroke distribution as seen on MR imaging diffusion-weighted imaging (DWI).

MATERIALS & METHODS

A retrospective review of all patients presenting at our institution between July 1, 2001 and July 1, 2002 who were diagnosed with either stroke or TIA, identified by ICD-9 code of 435.9 or 436, and who also underwent cerebral DSA and MRA, or DSA and DWI, as identified by the following CPT codes 70552, 70551, 70553, 70541, 70541, and 36216, was performed. Digital subtraction angiography was considered to be the gold standard for determining intracranial stenosis. On DSA, significant stenosis of the intracranial ICA, MCA, and vertebrobasilar circulation was judged to be $\geq 50\%$ narrowing. When the degree of intracranial stenosis was not reported in terms of percentages, angiograms were reviewed by 2 radiologist (AKF and GR). Intracranial MRA reports were evaluated by 2 radiologists (BPG and GR) as follows. When stenosis was reported in a vessel, this was assumed to represent $\geq 50\%$ narrowing. When terms other than stenosis were used to describe a vessel they were interpreted as follows: Few branch vessels seen = parent artery patent; absent or not seen = occlusion or severe stenosis; slow flow or severe irregularity = stenosis. Intracranial MRA technique at our institution is as follows: 3D single slab TOF SPGR, TR/TE, 6.9 msec/37 msec; flip angle, 20 degrees; bandwidth, 15.63 khz; FOV, 22 cm; phase FOV, 0.75; matrix, 320 x 224; slice thickness, 1.4 mm processed to 0.7 mm; excitations, 1 with superior saturation band and magnetization transfer. Diffusion-weighted images reporting restricted diffusion were evaluated for vascular territory of acute infarction.

RESULTS

Twenty-two of 37 patients that had undergone MRA and DSA following TIA or stroke were found to have a significant intracranial stenosis on DSA. Overall sensitivity and specificity of MRA for determining intracranial stenosis was calculated to be 42.9% (95% CI, 26.8-60.5) and 92.1% (95% CI, 87.1-95.4), respectively. Thirty-nine patients had an acute stroke on DWI, and 23 lesions were in the vascular distribution of the stenotic vessel as seen on DSA, while 9 lesions were not in the distribution of a stenotic vessel, and 7 lesions did not have any intracranial stenosis.

CONCLUSION

While MRA findings for intracranial stenosis are highly specific, MRA as it is commonly practiced at our institution is not sensitive for the detection of intracranial stenosis.

Therefore, this form of MRA is not suitable as a screening exam for intracranial stenosis. Since 59% (95% CI, 42-74) of all stroke cases and 72% (95% CI, 53-86) of stroke cases with a significant intracranial stenosis had a DWI infarct in the distribution of the stenotic vessel, such poor sensitivity may grossly under-diagnose symptomatic intracranial stenosis. As medical and endovascular therapy of these lesions advance, accurate means of screening will gain in importance.

KEY WORDS: Stroke, MR angiography, intracranial stenosis

Poster 8

Are Rapid Access Transient Ischemic Attack Clinics Rapid Enough?

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PURPOSE

Rapid access clinics for patients with transient ischemic attacks (TIA) were established to provide a rapid diagnostic service for those with suspected TIA or minor strokes. The aim of this study was to review the outcomes of those who were referred to the clinic.

MATERIALS & METHODS

One thousand four hundred sixty patients were referred to the clinic in the 27 months between October 2000 to December 2002. One thousand three hundred thirty-nine patients attended and the reports of carotid Doppler ultrasound were reviewed. Those who subsequently proceeded to carotid angiography and intervention of the carotid stenosis also were reviewed. One hundred twenty-one patients failed to attend the clinic and the reasons for this were recorded from the medical notes and the general practitioners.

RESULTS

The median waiting time from referral to appointment was 17 days (0-90 days). One hundred of 1339 (7.5%) had greater than 50% stenosis on the appropriate side of symptoms. Eighty-three of 1339 (6.2%) patients proceeded to cerebral angiography and 65/1339 (4.9%) patients had intervention for the carotid stenosis. Thirty-nine of 121 (32.2%) of those who did not attend the clinic did so because they had had a completed stroke in the interval between seeing their GP and the clinic appointment. Twenty-seven of 39 (71%) of the strokes occurred within the first 3 days of referral.

CONCLUSION

Only a small proportion of those who attended the clinic had direct intervention on the carotid stenosis. Nonattendees had a high risk of stroke in the first few days after TIA, suggesting that highest risk patients were not seen in time. This emphasizes the need for a more aggressive approach to prevent stroke progression.

KEY WORDS: Transient ischemic attacks, carotid artery stenosis

Poster 9**Relationship of Cerebral Blood Flow, Cerebral Vasoreactivity, and Hematocrit in Xenon CT Cerebral Blood Flow Measurement**

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PURPOSE

Measurement of cerebral blood flow is dependent on the patient's hematocrit. We try to evaluate the relationship between the cerebral blood flow, cerebral vasoreactivity, and hematocrit in different groups of normal, patient with infarct, patient with cervical stenosis.

MATERIALS & METHODS

Fifty persons were included in this study; there were 24 males and 26 females. Ages ranged from 40 to 78 years old. We used 5 different hematocrit (20%, 25%, 30%, 35%, 40%, and 45%) values to calculate the cerebral blood flow. All the region of interest (ROI) was in the same location. The same study was repeated with Diamox challenge.

RESULTS

If all the other parameters were consistent, a reverse linear relationship was shown between the hematocrit and the cerebral blood flow. All the R^2 value was more than -0.98 in the normal side, infarcted side, and the side with cervical carotid stenosis.

CONCLUSION

Hematocrit reveals reverse linear relationship with cerebral blood flow when xenon CT used for cerebral blood flow measurement. The finding is compatible to the prior animals study and the effect of hemodilution is confirmed in human being.

KEY WORDS: Cerebral blood flow, hematocrit, xenon

Poster 10**First-Pass Perfusion CT in Acute Middle Cerebral Artery Ischemic Stroke**

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PURPOSE

To assess the utility of first-pass perfusion CT in the relationship between lesion size revealed by perfusion CT and clinical outcome, and the prediction of final infarct lesion in acute ischemic stroke patients who have not undergone thrombolytic therapy.

MATERIALS & METHODS

Fifty-five patients underwent first-pass perfusion CT within 6 hours of stroke onset. The first-pass perfusion CT examination consisted of two 40-second series at 5 minute intervals. Multidetector-array technology allowed data acquisition from 2 adjacent 10 mm sections for each series. Thus the two perfusion CT series allowed data acquisition of 4 cere-

bral sections at the level of the basal ganglia and the centrum semiovale. Cerebral blood flow, CBV, and MTT maps were obtained from serial CT images, and the initial lesion size, revealed by perfusion CT, were compared with clinical scores and final infarct size.

RESULTS

Overall, the lesion size seen on CBV maps correlated most strongly with final infarct size ($R^2 = 0.847$, $p < 0.001$). Individual data of CBV maps showed that each perfusion defect lesions were less than CBF and MTT maps in 96% of patients. Cerebral blood flow and MTT maps showed sensitive perfusion abnormal findings of MCA territory involved, but final infarct area tended to be overestimated by CBF and MTT maps. The lesion size depicted by CBV maps showed moderate correlation with baseline clinical scores and clinical outcomes ($R^2 = 0.531$, $p < 0.001$).

CONCLUSION

First-pass perfusion CT scan is a practical and rapid advanced imaging technique. It provides important hemodynamic information in acute stroke patients, thus offers reliable information, which brain tissue is salvageable by thrombolytic therapy, and in predicting the outcomes.

KEY WORDS: Brain, ischemia, CT

Poster 11**Brain MR Abnormalities in Renal Transplant Patients**

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PURPOSE

The purpose of the study was to establish the incidence of neurologic symptoms in kidney transplanted patients (KTP) as well as to describe the spectrum and location of brain MR abnormalities.

MATERIALS & METHODS

Out of 744 KTP patients, 72 adults (9.7%) aged 18 to 72 years old (mean 54 years old) exhibited various neurologic symptoms and were evaluated by a total of 92 brain MR studies. Patients were put into 3 groups based on how long after transplantation that the brain MR was performed. Group 1 consists of 17 patients imaged up to 3 months after transplantation. Group II consists of 20 patients imaged 3 months up to 1 year after transplantation. Group 3 consists of 35 patients imaged more than 1 year after transplantation. Two neuroradiologists independently and retrospectively reviewed MR images and a final consensus was made. In most patients, standard MR brain protocol was used including sagittal T1, axial T2, axial FLAIR, and axial and coronal postcontrast sequences. Diffusion-weighted images were done in 66 patients. In 5 patients, MRA was done. In 2 patients, an MR sella protocol was performed, and one patient required an MR orbits.

RESULTS

The most common clinical symptoms were as follows: altered mental status (25%), headache (22.2%), seizures (16.7%), blurry vision (9.7%), confusion (9.7%), hemiparesis (9.7%), weakness (8.3%), and dizziness (6.9%). Other symptoms like gait abnormality, syncope, and lethargy were less common. The symptom duration, magnesium, cholesterol, and calcineurine inhibitor levels were analyzed. At time of MR imaging, serum levels of cyclosporine A and tacrolimus were within the normal range. In 25 (20.8%) patients, the brain MR was normal. MR imaging lesions typically had hyperintense signal on T2 and FLAIR sequences and isointense or hypointense signal on T1. Vascular changes including various types of infarction and scattered white matter ischemic changes related to microangiopathy were present in a total 49 out of 72 (68.1%) patients. Interestingly, these lesions were seen more commonly in a white matter distribution in the periventricular and subcortical frontal region. Additional diagnoses included infection in 5 patients (6.9%), posterior reversible encephalopathy syndrome (PRES) in 2 patients (2.8%), and cerebellar lymphoma in 1 patient (1.4%). In 6 patients (8.3%), there were additional findings within the calvarium related to renal osteodystrophy and occurred only in patients who received multiple renal transplants. Other unrelated imaging findings included meningioma in 2 patients (2.8%), temporal bone tumor in 1 patient (1.4%), and venous developmental anomaly in 2 patients (2.8%).

CONCLUSION

In kidney transplant patients various neurologic symptoms and imaging features may be observed. Hemispheric white matter changes were significantly more common than changes in gray matter. Ischemic changes predominate in this patient population. Infection can be expected in the first months after transplantation while PRES can occur later. Changes in the calvarium and de novo malignancies also can occur.

KEY WORDS: Kidney transplant, MR imaging

Poster 12

Evaluation of Early Infarct Volume as Assessed by CT Perfusion- and Diffusion-Weighted MR Imaging in Stroke Patients

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PURPOSE

In the acute phase of cerebral ischemia intraindividual assessment of infarct volume by means of different imaging modalities is limited to single subjects because of narrow therapeutic windows. We present first results from a study to compare early infarct volume as assessed by CT perfusion (CTP) and MR diffusion-weighted imaging (DWI) in stroke patients.

MATERIALS & METHODS

Seven patients (age range 52 - 89 years) with clinical signs of acute cerebral ischemia underwent CTP in the mean 4.3 hours after symptom onset; DWI was performed 6.0 hours

after the onset of symptoms in the mean. Parameter maps of cerebral blood perfusion (CBP), cerebral blood volume (CBV) and mean transit time (MTT) were generated. Volume of diffusion abnormality was compared with the infarct volumes as assessed by two blinded neuroradiologists for each of the perfusion maps.

RESULTS

All patients developed infarction on follow-up studies. Six patients showed perfusions deficits in all perfusion images. In one patient, who had no DWI abnormality, perfusion deficits only were found on CBP and MTT images. Mean volumes of ischemia as assessed by CBP, CBV, and MTT were 36.0, 16.5, 40.7 ml, respectively. Mean volume of DWI changes was 25.1 ml. The most significant correlation was found between the extension of CBV reduction and the early infarct volume assessed by DWI ($r = 0.862$, $P < 0.01$).

CONCLUSION

Our preliminary results suggest that CBV maps based on the CTP technique applied in this study permit prediction of infarct volume in early stroke, so CTP would deliver information about the ischemic penumbra.

KEY WORDS: Stroke, CT perfusion, diffusion-weighted imaging

Poster 13

Rate of Atrophy within the Medial Temporal Lobe as a Diagnostic Marker of Alzheimer's Disease

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PURPOSE

Increased volume loss occurs within medial temporal lobe (MTL) in Alzheimer's disease (AD) patients (1). However, atrophy occurs with age even in normal elderly. The rate of atrophy also has been shown to be higher in AD compared to control groups (2). This study evaluates the utility of the annual MTL atrophy rate, as measured by serial MR imaging using automated software tools, in differentiating AD from control.

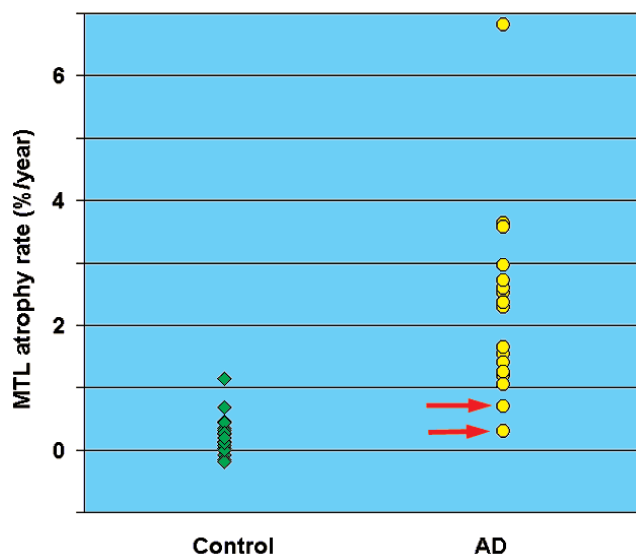
MATERIALS & METHODS

Among subjects evaluated in our AD center, we selected those with at least 2 MR images and with known time of onset of AD (range 2.9 years prior to onset to 4.2 years after onset). The control group consisted of elderly subjects without cognitive impairment. Baseline and follow-up MR images were coregistered (3), and the region of interest (ROI) incorporating the left and right MTL was constructed. The annual atrophy rate was calculated using a locally developed automated brain boundary shift procedure.

RESULTS

Eighteen AD subjects (5 men/13 women, ages 54-85 years, baseline Mini Mental Status Exam score 26.0 ± 3.4) and 21 normal controls (7 men/14 women, ages 60-78 years) fulfilled the inclusion criteria for the study. The mean MTL atrophy rate was $2.2 \pm 1.5\%$ per year for the AD group and

0.3 $\pm$ 0.3% per year for the control (Figure). In either group, there was no significant correlation between the MTL atrophy rate and age, gender, or education. Logistic regression aimed at predicting the group given the age, gender, education, and MTL atrophy rate yielded a diagnostic accuracy of 92.3%, with 20/21 control and 16/18 AD subjects correctly classified. The two falsely classified AD patients were both imaged 2.8-2.9 years before the diagnosis of probable AD (arrows, Figure). The maximum discrepancy in estimating the annual MTL atrophy rate by the two observers was only 0.11% (mean absolute discrepancy 0.06%).



CONCLUSION

The annual MTL atrophy rate may be a candidate for a diagnostic marker, as it was able to distinguish AD from control with 92.3% accuracy. Regional brain atrophy rate may be used to monitor the progression of AD and patients' response to therapy.

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KEY WORDS: Alzheimer's disease, MR imaging, cerebral atrophy

Poster 14

A Longitudinal Study in Patients with Early Relapsing-Remitting Multiple Sclerosis: Diffusion MR Imaging Changes in Normal-Appearing White Matter

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PURPOSE

Several reports have demonstrated increased tADC values in multiple sclerosis (MS) patients white matter that appears normal (NAWM) on studies obtained with conventional techniques. The present study investigates water diffusion changes over time and their relationship to different clinical activity and disability status in NAWM of patients with early relapsing-remitting MS.

MATERIALS & METHODS

We selected 54 early MS patients and 18 age-matched healthy controls. Conventional MR study and diffusion MR imaging (DWI) study were obtained. Inclusion criteria were: a) definite relapsing-remitting MS according to MC Donald's criteria; b) age between 18 and 50 years (mean age 37.4 years); c) drug free for at least 60 days before enrollment; d) expanded disability status scale (EDSS) < 3.5. In a second step 18 out of 54 patients completed a 6 month clinical and MR imaging follow-up (baseline, 3 months and 6 months). Nine of them had one relapsing episode during the 6 month follow-up. Bilateral and symmetrical ROIs (elliptical, 60 pixels) were drawn on FLAIR images in frontal WM, parietal WM, centrum semiovale, and middle cerebellar peduncle and then transferred onto the trace maps to obtain the corresponding tADC values. Regions of interest were never placed over areas hyperintense on FLAIR and T2-weighted imaging.

RESULTS

TADC of NAWM of MS patients was significantly higher than in controls (patients mean tADC $\pm$ SD = 0.768 ± 0.040 mm²/sec $\times 10^{-3}$; controls mean tADC $\pm$ SD = 0.699 ± 0.036 mm²/sec $\times 10^{-3}$; $p < 0.001$). TADC of NAWM of patients with EDSS ≥ 2 was significantly higher than patients with EDSS < 2 (patients with EDSS ≥ 2 mean tADC $\pm$ SD = 0.787 ± 0.036 mm²/sec $\times 10^{-3}$; patients with EDSS < 2 mean tADC $\pm$ SD = 0.748 ± 0.038 mm²/sec $\times 10^{-3}$; $p < 0.001$). TADC of NAWM of relapsing patients was significantly higher than remitting patients (relapsing patients mean tADC $\pm$ SD = 0.801 ± 0.027 mm²/sec $\times 10^{-3}$; remitting patients mean tADC $\pm$ SD = 0.760 ± 0.043 mm²/sec $\times 10^{-3}$; $p < 0.001$). The longitudinal study completed in 18 of 54 patients showed no statistically significant differences in mean tADC of NAWM at the different time points studied (T0, T3, T6). However tADC of the 9 patients that had a relapsing episode was significantly higher in their relapsing phase than in their remitting phase (relapsing phase mean tADC $\pm$ SD = 0.787 ± 0.034 mm²/sec $\times 10^{-3}$; remitting phase mean tADC $\pm$ SD = 0.737 ± 0.026 mm²/sec $\times 10^{-3}$; $p < 0.001$).

CONCLUSION

This study suggests that DWI can detect subtle alterations in NAWM in relapsing-remitting MS even in the early stage of the disease. These alterations are correlated with disability status and clinical activity. TADC changes in NAWM may suggest ultrastructural alterations related to a more widespread WM inflammatory process. These findings may represent variation in modulating factors (neurotransmission and immunity) associated to inflammation and partially independent of the presence and extent of axonal destruction.

KEY WORDS: Multiple sclerosis, MR imaging, diffusion-weighted imaging

Poster 15

Progressive Multifocal Leukoencephalopathy: Imaging "A Pictorial Essay"

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PURPOSE

To study the spectrum of neuroimaging findings in 40 cases of pathologically proven progressive multifocal leukoencephalopathy (PML) (in sero positive HIV and non HIV patients) and to correlate it with clinical data and implications.

MATERIALS & METHODS

It was a retrospective study of 40 patients (24 males and 16 females) with confirmed PML by pathologic analysis (29 autopsy reports, 11 stereotactic biopsy reports) reported from 1998-2002 (5 years). Out of 40 patients 37 were sero positive HIV, 2 were CLL-chronic lymphocytic leukemia patients and one had hypogammaglobulinemia. Thirty-six CT (34 contrast CT) and 29 MR (11 contrast MR) images were reviewed retrospectively and correlated with clinical and pathologic data. These images helped outline a neuroimaging spectrum, which will be presented in this visual presentation.

RESULTS

Out of 40 cases - *Typical features* were seen in 65% (26/40) cases as described in literature - multiple, asymmetrical, confluent and hypodense lesions on CT and hypointense on T1-weighted MR images and hyperintense on T2-weighted MR images. *Atypical features* were - unifocal lesions seen in 40% (16/40) cases, mild peripheral enhancement in 10% (4/40), mild atrophy in 15% (6/40) and deep gray matter involvement in 27.5% (11/40) cases. Site predilection noted in unifocal lesions was - high parietal lobe in 56% (9 /16) cases, temporo-occipital lobe in 12.5% (2 /16), and cerebellum in 18% (3/16) cases - with 2 out of them in middle cerebellar peduncle. Clinical presentation correlated with the site involved in case of unifocal lesions - such as ataxia in a lesion in cerebellum and vision abnormalities in a lesion in temporo-occipital lobes. Overall, mortality was 100% and mean survival time in multifocal white matter involvement was 4.6 months after diagnosis and 5.2 months in case of unifocal white matter involvement. However, the survival

time was very short (3.4 months) in those who showed deep gray matter involvement along with white matter involvement at the time of diagnosis (11/40 cases).

CONCLUSION

This study by using a *relatively larger sample* highlights the neuroimaging spectrum of "typical" and "atypical" findings of PML. Findings like the deep gray matter involvement seen clearly on neuroimaging proved to be an important prognostic sign for severity of disease. In a disease which is fatal and has no cure, invasive diagnostic procedures should be avoided and hence lays the importance of knowing the neuroimaging spectrum.

KEY WORDS: Progressive multifocal leukoencephalopathy

Poster 16

Can Hippocampal Volume Be an Indicator from Mild Cognitive Impairment to Alzheimer's Disease?: Three-Year Longitudinal Study of MR Hippocampal Volumetry

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PURPOSE

To evaluate if the hippocampal volume of the patients with mild cognitive impairment (MCI) at baseline and its annual decline can predict the development of Alzheimer's disease (AD), thus to serve as a risk factor for AD, and then as an indication for early antidementia treatment.

MATERIALS & METHODS

In the past 3 years, we prospectively have recruited 126 participants, including 30 normal controls, 75 patients with MCI and 21 patients with AD. All individuals received memory and neuropsychological tests, apoE genotyping, and MR study of hippocampal volumes. The high resolution oblique coronal fast spin-echo (FSE) heavily T2-weighted images with the imaging orientation perpendicular to the long axis of the hippocampus was done for presentation of the detailed structures of the hippocampi (TR/TE/NEX 4000/102/4, interleave 3 mm slice thickness). The area of the hippocampus was measured semiautomatically in another workstation by manually tracing the outline of this structure. The volume was obtained by the area timing the slice thickness (3 mm).

RESULTS

The average hippocampal volume of the AD patients was significantly smaller than those of the normal controls and MCI subjects, but there was no difference between those of controls and MCI individuals in the first year. Although the cognitive changes from the baseline were not different between the groups of the normal controls and MCI, the MCI subjects showed significant decline in the hippocampal volume compared to the controls in the second year. This implies that the hippocampal volume may be more sensitive than the cognitive decline in MCI subjects. In the third year, the MCI subjects had significant decline in most of the cognitive tests and also hippocampal volumes.

CONCLUSION

The MR hippocampal volumetry can be a more sensitive predictor than the cognitive tests for the patients with MCI at an increased risk for developing AD.

KEY WORDS: Hippocampus, Alzheimer's disease, MR imaging

Poster 17**High Field (7 T) MR Imaging of Post-Mortem Multiple Sclerosis Brain**

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PURPOSE

To evaluate MR imaging characteristics (T1, T2) of post-mortem (PM) multiple sclerosis (MS) brain under fresh conditions and after fixation using a 7 T scanner.

MATERIALS & METHODS

One tissue block of a fresh PM MS brain slice was used. After scanning under fresh conditions, the specimen was fixed in 10% formaldehyde and scanned 6 times within 8 weeks. MR imaging was performed on a 7 T Bruker Biospec spectrometer using a 2 cm diameter saddle coil. Images were acquired with a field of view of 3 cm, an image matrix of 192 x 256, and a slice thickness of 0.5 cm. Four sets of inversion recovery images were acquired with imaging parameters: TE = 16 ms, TR = 5000 ms and inversion times (TI) = 100 ms, 1000 ms, 2000 ms, and 4000 ms. Two sets of spin-echo images were acquired (TE = 20 ms and 60 ms, TR = 2000 ms). T1 and T2 parameter maps were produced. For one slice at each timepoint, coregistered to the initial scan, T1 and T2 were measured in the normal appearing (NA) white matter (WM) and the NA gray matter (GM), and in lesions. After the final scan, the tissue block was processed for embedding in paraffin and sections stained (H&E, Luxol-Fast blue, Bielschowsky's silver impregnation). A Leica Q500MC image analyzer was used to quantify myelin by measuring transmittance (Tr) on LFB-stained slides. Point-counting was performed to quantify axons.

RESULTS

Two chronic inactive MS lesions were detected on MR imaging and confirmed histologically. One demyelinated lesion included the WM and cortical GM, the second was a remyelinated WM lesion. Coregistration between MR imaging and histology, and between scans at the different timepoints was excellent. After fixation T1 of NAWM and NAGM decreased by 40% within 60 days of fixation ($p < 0.01$; paired t-test). T2 increased after fixation by 25% in NAWM and by 10-25% in NAGM. Tissue contrast was similar on both T1 and T2 maps before and after fixation. Good contrast was seen between the WM lesions and NAWM for both T1 and T2 maps, whereas between the GM portion of one lesion and the NAGM into which it protruded only T2 showed good contrast. Despite a substantial difference in their myelin content, T1, and T2 both lesions displayed only mild axonal loss.

CONCLUSION

Due to its high resolution and good tissue contrast, MR imaging at 7 T appears to be an excellent tool to study in detail the pathologic substrates of quantitative MR imaging changes in PM MS brain, in particular GM and remyelinated lesions. Such lesions should be further characterized in a larger sample by using other quantitative MR imaging measures, such as diffusion-weighted MR imaging and magnetization transfer imaging. Formaldehyde fixation leads to changes in the microstructure of the tissue with subsequent changes of T1 and T2. However, the contrast between NAWM and NAGM for both T1 and T2 did not change substantially in our sample as opposed to studies at lower field. Our observations suggest that fixed MS brain may be a useful substitute if fresh tissue is not available for such studies.

KEY WORDS: High field MR imaging, multiple sclerosis, neuropathology

Poster 18**Physiologically Specific Imaging of Posterior Reversible Encephalopathy Syndrome**

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PURPOSE

Posterior reversible encephalopathy syndrome (PRES) is a disease complex characterized by headache, seizure, confusion, and visual dysfunction. It is seen in a variety of clinical settings such as acute hypertension, renal failure, and in relation to medications such as cyclosporine. Imaging shows characteristic lesions predominantly within the white matter of the posterior circulation. The postulated etiology is that there is a loss of cerebral blood flow autoregulation with a breakdown in the blood-brain barrier and vasogenic edema. Our goal was to evaluate the physiologically specific MR imaging features of PRES using perfusion and diffusion sensitive pulse sequences in an attempt to characterize the pathology in terms of its vascular and cellular microenvironment.

MATERIALS & METHODS

A retrospective analysis of all the MR imaging reports of the brain scanned between January 2002 to November 2003 was performed. Only cases of PRES which included MR perfusion imaging exams were included. All cases were imaged using a GE 1.5 T scanner and had gradient-echo echo-planar imaging performed following intravenous injection of gadolinium as well as diffusion-weighted EPI ($b = 1000$ s/mm²). The cases were analyzed using a GE Advantage Workstation version 4.0 utilizing Functool software. Relative cerebral blood volume (negative enhancement integral, NEI) and bolus transit time (mean time to enhance, MTE) measurements were assessed. In each case, these measurements were made for the largest visible lesion as well as for the unaffected ipsilateral caudate head and contralateral homologous unaffected white matter.

RESULTS

Four individual cases were identified consisting of 4 females (average age 45.25 years). Three of the cases occurred in patients on cyclosporine therapy. The remaining patient had a history of chronic renal failure and hypertension. All cases were scanned within a 24-hour period following a presenting neurologic event. Diffusion coefficients were elevated significantly in lesions ($1.46 \pm 0.25 \times 10^{-3} \text{ mm}^2/\text{s}$) compared to control regions ($0.775 \pm 0.014 \times 10^{-3} \text{ mm}^2/\text{s}$, $p < 0.05$). MTE in lesions ($1.45 \pm 0.13\text{s}$) did not show any statistical difference compared to ipsilateral caudate head ($1.43 \pm 0.13\text{s}$, $p > 0.1$). Lesion and control (caudate) values showed strong correlation ($r = 0.99$). A comparison of the lesion NEI (66.4 ± 9.0) to a contralateral area of unaffected white matter NEI (64.5 ± 13.6) also did not show statistical difference ($p > 0.9$). Graphs of “control vs lesion” for both NEI, MTE, and ADC values are seen in Figure 1.

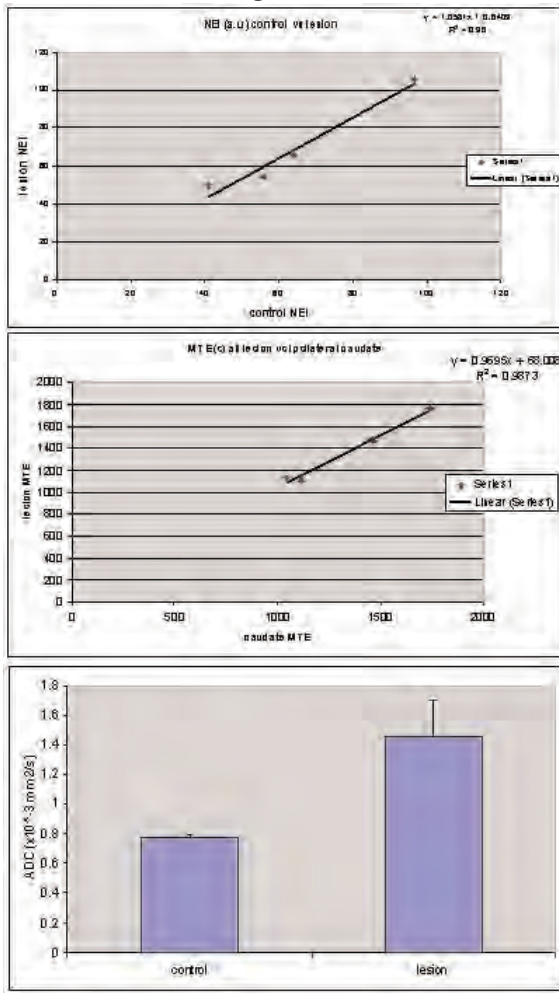


Figure 1.

CONCLUSION

MR perfusion analysis of 4 cases of PRES did not show any regional difference in relative cerebral blood volume or bolus transit time when comparing lesion foci to areas of normal brain, despite pronounced elevation of apparent diffusion coefficient. This shows that there is no focal perfusion abnormality within the affected areas, while supporting the hypothesis of vasogenic edema secondary to BBB disruption.

KEY WORDS: Perfusion, diffusion, PRES

Poster 20

Diffusion Tensor MR Imaging in Multiple Sclerosis

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PURPOSE

To determine whether diffusion tensor (DT) MR imaging can demonstrate differences in acute and chronic multiple sclerosis (MS) plaques and to assess the normal appearing white matter (NAWM) surrounding the plaques to determine the real extent of the lesions.

MATERIALS & METHODS

Twenty-seven MS patients (21 female, 6 male; mean age 32 years old) and 15 healthy controls age-matched (9 male, 6 female; mean age 29 years old) underwent diffusion tensor and conventional MR imaging exam performed in a 1.5 T clinical scanner (Siemens, Germany). Generation of fractional anisotropy (FA) maps was performed in all patients. Identical regions of interest (ROIs) were placed by an experienced neuroradiologist on the plaques, in the NAWM surrounding the lesions and at the corresponding location in the control group. Multiple sclerosis lesions were classified as acute or chronic plaques, depending on their appearance in the conventional MR imaging and clinical symptoms.

RESULTS

The mean FA measured in acute plaque demonstrated reduced anisotropy 50% that of the averaged corresponding normal white matter (NWM) in controls subjects. Chronic plaques had 65% of reduction comparing to NWM. There was a difference of about 30% between the FA values of acute and chronic plaques. The mean FA of NAWM surrounding the plaque was 80% of the value of NWM in control subjects. The abnormalities founded in the plaques FA values and in the NAWM surrounding them demonstrated that the average plaque size increased around 150% of the size visualized in conventional MR imaging.

CONCLUSION

These results suggest that DT imaging may represent a more accurate MR imaging method to determinate the extent of the demyelinating process in MS patients and also contribute in the identification and differential diagnosis between acute and chronic plaques.

KEY WORDS: Multiple sclerosis, diffusion tensor

Poster 21**Lesions of the Corpus Callosum**

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PURPOSE

A pictorial review of the MR findings of lesions of the corpus callosum and summary of helpful radiographic features to differentiate among these lesions.

MATERIALS & METHODS

We retrospectively reviewed cases of pathology of the corpus callosum collected over the past 10 years.

RESULTS

There is a wide spectrum of diseases that involve the corpus callosum. These can be summarized under broad categories of congenital/developmental, neoplastic, vascular, inflammatory, demyelinating, and posttraumatic. These are discussed with emphasis on differential imaging characteristics.

CONCLUSION

The imaging features encompassing the spectrum of abnormalities that involve the corpus callosum are summarized in this pictorial essay.

KEY WORDS: Corpus callosum, epilepsy, postictal

Poster 22**Brain Atrophy in Normal Aging: A Morphometric Evaluation of 525 Brains**

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PURPOSE

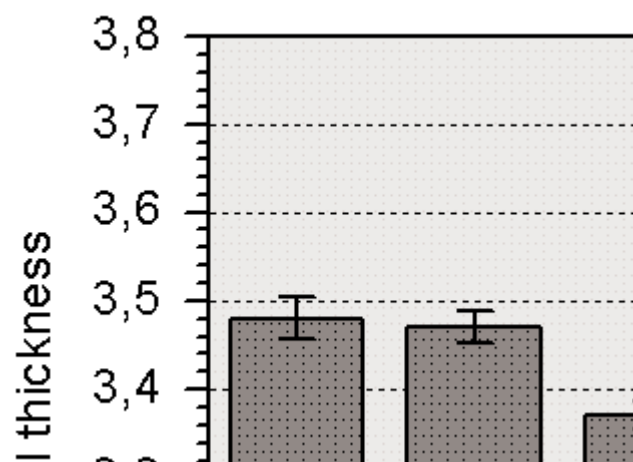
To morphometrically evaluate if external atrophy and internal atrophy physiologically appear with advancing age. The effects of gender and handedness on morphometric values were tested in a large sample of normal subjects.

MATERIALS & METHODS

Three-dimensional MR images of 525 healthy volunteers (17-68 years) were analyzed retrospectively for cortical thickness and planimetrically determined ventricular indices (ventricular body index, anterior horn index, 3rd ventricular width). Age groups 1-6 covering 6 decades of normal aging were defined. Cortical thickness was assessed using an automated algorithm.

RESULTS

Cortical thickness decreases significantly every other decade of normal aging (3.5 mm $\pm$ 0.1 to 3.2 mm $\pm$ 0.1 comparing groups 1 and 6). The ventricular parameters scale up as well, in particular the third ventricle (4.1 $\pm$ 0.7 mm for group 1 to 7.7 $\pm$ 2.7 mm for group 6). External and internal atrophy are strongly related ($p < 0.01$, $r = -0.583$) and both show a strong correlation with age ($r = -0.69$ and $r = 0.65$).

**CONCLUSION**

Our results suggest that brain atrophy physiologically occurs with normal aging. Cortical thickness decreases in plateaus every other decade from teenage-life on, whereas the ventricular parameters increase more constantly. Our morphometric analysis provides valuable information for the evaluation of MR images in terms of a physiologic or nonphysiologic atrophy with advancing age.

KEY WORDS: Normal aging, cortical thickness, morphometry

Poster 23**Selective Brain Atrophy and Cognitive Impairment in Relapsing Forms of Multiple Sclerosis**

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PURPOSE

Cognitive impairment is common in multiple sclerosis (MS) and various mechanisms have been proposed to explain it. A relationship also has been observed between whole-brain atrophy and cognitive impairment, although the role of regional atrophy has been studied less extensively. In consequence, the objective of this work is to study the association between cognitive impairment and selective normalized volumes of the brain (gray and white matter).

MATERIALS & METHODS

A total of 20 MS patients and 11 healthy controls participated in the study approved by the Research and Ethics Committee of our hospital. MS patients were assessed by means of a comprehensive neuropsychological battery designed to assess attention, memory, executive functions, and visuospatial abilities. One deterioration mark was given

to each patient when the performance on the test was below 2 standard deviations from test published norms. Cognitive impairment was defined as failure of 4 or more tests. MR studies of patients and controls were performed with a 1.5 T magnet. MR studies consisted of T2- and T1-weighted images (contiguous 3 mm slice thickness covering the whole brain) from which the intracranial region, brain parenchyma, white and gray matter volumes were determined by means of in-house developed software. Measures of brain parenchyma fraction (BPF), white matter fraction (WMF) and gray matter fraction (GMF) were obtained from the ratio between the volumes of these regions and the intracranial region volume. ANOVA and Bonferroni post-hoc test with a $p < 0.05$ significant level were used to assess significant differences among groups.

RESULTS

Nine MS patients showed cognitive impairment. There were no statistical differences in age, EDSS, years of education, and disease duration between cognitively impaired (CIMS) and nonimpaired (CNMS) MS patients. BPF values showed significant differences between controls and both MS groups as well as between unimpaired and impaired MS groups. White matter fraction values were decreased significantly in both MS groups as compared to the controls. Gray matter fraction values were decreased significantly in impaired patients with respect to unimpaired patients and controls; nevertheless, in unimpaired patients, GMF values were similar to the controls.

CONCLUSION

In agreement with previous works, our study shows that cognitive impairment in MS is associated with brain tissue loss. Additionally, our results suggest that gray matter loss contribute to the pathologic process responsible for the cognitive impairment observed in relapsing MS patients.

KEY WORDS: Multiple sclerosis, brain, MR imaging

The authors of this work have indicated the following affiliations/disclosures: "Fondo de Investigación Sanitaria" of the "Ministerio de Sanidad y Consumo" FIS Ref. 99/0236: Grant.

Poster 24

Afflictions of the Pons: Distinctive MR Features Revisited

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PURPOSE

Familiarity to the complex anatomical constituents of the pons and recognition of the predilection tendency and pathologically related MR features of certain disease processes constitute the major objectives of this presentation.

MATERIALS & METHODS

We present different cases of pontine lesions and analyze the diagnostic approach with emphasis on the differential diagnosis.

RESULTS

As hereby anatomically depicted, the pons is the central portion of the brainstem, intrinsically constituted by descending and ascending white matter motor tracts, along with gray matter nuclei of the cranial nerves V, VI, VII, and VIII. Certain disease processes may exhibit predilection for a particular anatomical constituent of the brainstem and close integrated analysis of their tendencies with the basic MR imaging findings would enhance our capabilities of understanding the underlying pathologic substrates and accuracy of diagnosis of the lesions. Overall, there is a broad differential diagnosis for lesions of the pons which would include infarcts, primary and secondary neoplasm, demyelinating disease, osmotic demyelination, vascular malformation, and rhombencephalitis. Definitive diagnosis may not be attainable particularly with viral encephalitis. Management nevertheless may be influenced heavily by the clinical concerns and prevalent radiologic diagnostic consideration. Our presentation will include cases that can be categorized as complex and difficult. Multiple sclerosis, a demyelinating disorder that frequently involves the periventricular white matter and corpus callosum may affect the white matter tracts of the pons including the middle cerebellar peduncles. Recent and active lesions can be identified as areas of restricted diffusion on the diffusion-weighted imaging sequence and may exhibit paramagnetic contrast enhancement. The lesions are particularly most conspicuous on the long TR images. Osmotic myelinolysis is characterized by symmetric demyelination of the base of the pons, spreading centrifugally from the median raphe. Focal myelinolysis also can be seen in the cerebral peduncles, lateral thalami, basal ganglia, and corticomedullary junction of the cerebellar hemispheres. The lesions that are of low T1 and high T2 intensities are preponderantly delineated in the distribution of the transverse pontine fibers with sparing of the corticospinal tracts. Most of the lesions do not enhance. Subacute sclerosing panencephalitis (SSPE) preponderantly affects the periventricular and subcortical white matter and basal ganglia. With involvement of the brainstem, there is predilection for the white matter tracts and substantia nigra with relative sparing of the pontine tegmentum. In acute disseminated encephalomyelitis (ADEM), a disease process considered to be autoimmune mediated, perivenular demyelination and inflammatory changes including gliosis, affect the deep white matter structures of the brainstem and cerebellum. Gray matter involvement also may be evident. Paramagnetic contrast enhancement particularly with use of double dose often observed. Unless complicated by infarctions or hemorrhage, most of the lesions resolve. The changes of encephalomyelitis are overall most conspicuous on the long TR images. We have observed restricted areas of diffusion in the cases with corresponding areas of contrast enhancement.

CONCLUSION

Although differential diagnosis of disease processes affecting the pons can be challenging, analysis of anatomical predilection, MR features, and clinical correlation can give a clue to the management.

KEY WORDS: Pons, demyelination, inflammatory

Poster 25

Quantitative Morphologic Study of Hippocampus in Alzheimer's Disease

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PURPOSE

To compare hippocampal morphometry in Alzheimer's disease based on a manual and automated segmentation.

MATERIALS & METHODS

Subjects met NINCDS/ADRDA criterion for the diagnosis of Alzheimer's disease and had a minimental status exam score within the range of 10-24. MR images of four Alzheimer's subjects and three controls were obtained with a 1.5 T GE Sigma scanner from UMDNJ-RWJMS using a standard head coil with a coronal 3D spoiled gradient-echo sequence (SPGR) TR 25 msec, TE 5 msec, flip angle 40 degrees, bandwidth 10.42, matrix 256 x 192, FOV 240 mm, slice thickness 1.5 mm). Hippocampal structures were segmented by manual contouring using Analyze software (Mayo Clinic) and by automated mean shift algorithm developed in house. Volumes subsequently were calculated. The manual segmentations were performed by the same expert rated on two occasions, separated by an interval of several days. Regions of interest included the hippocampal head, body, and tail. The most posterior extent of the hippocampal tail was at the coronal image demonstrating the retrosplenial gyrus of the corpus callosum. The anterior border of the hippocampal head was the subiculum at the interface with the amygdala. The alveus and subiculum were included in volume analysis while the fornix and fibria were excluded. The automated segmentation decomposition of a gray level image into homogenous tiles was performed on a slice-by-slice basis. The image is interpreted as a joint spatial-range domain where the spatial domain is defined by the (x, y) coordinates and the range domain is defined by the intensity value. The modes are stationary points where the gradient of the joint density function is zero. Each pixel becomes associated with a significant mode of the joint domain density located in its neighborhood and after nearby modes are pruned the segmentation results. We use double elliptic Fourier descriptors to quantify changes in the shape of the hippocampus in Alzheimer's subjects.

RESULTS

Manually segmented volumes were significantly lower in Alzheimer's subjects than in controls. The right and left hippocampal volumes were reduced 34% in the subjects with Alzheimer's disease when compared to the controls. The volume loss in patients' hippocampus was associated with the shape changes. The accuracy of the automated segmentation will be determined by calculating the average percentage difference.

CONCLUSION

The availability of automatic tools for neuromorphometry in conjunction with morphometric analysis should improve our understanding of neurologic disorders.

KEY WORDS: Alzheimer's disease, hippocampus

Poster 26

Delayed Encephalopathy after Acute Carbon Monoxide Poisoning: Mismatch between Diffusion-Weighted and Diffusion Tensor MR Imaging

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PURPOSE

A delayed neurological syndrome (DNS) occurs in 15% of acute carbon monoxide poisoning (ACMP) cases. The severity of white matter (WM) lesions varies from simple pale staining myelin sheaths, demyelination with spared axons, to confluent necrotic plaques (1). Some authors (2, 3) suggest that diffusion-weighted imaging (DWI) may be helpful for early identification of WM changes, though unrelated to clinical defects. We present a case that had better clinical correlation with diffusion tensor image (DTI) than DWI.

MATERIALS & METHODS

A 51-year-old man was admitted in coma for ACMP. The patient was intubated and ventilated with oxygen, recovering consciousness 6 hours later. MR imaging showed globus pallidus lesions, and diffuse high intensity of WM on T2-weighted imaging. At home 3 weeks later, the patient developed cognitive and motor impairment to progress to an akinetic mutism with incontinence within 10 days. MR imaging revealed increased signal intensity of WM in T2 and FLAIR. High signal intensity was seen at the same locations in DWI and apparent diffusion coefficient (ADC), with lower ADC values in frontal WM. Fractional anisotropy maps (FAM) showed qualitative frontal periventricular changes, and asymmetrical lower values in bifrontal WM. With a diagnosis of DNS, hyperbaric oxygen therapy was administered (35 daily sessions of 45 min. each, at 2.5 absolute atm.). Treatment then was started with L-dopa agonist. Three months after ACMP, examination revealed right frontal signs and axial paratonia, cognitive frontal-subcortical impairment (Frontal Assessment Battery score 14), Barthel Index score 100, Folstein Mini Mental State Examination score 29, and Rankin score 1 pt. Five months after onset, clinical examination and FAM were normal. MR imaging was performed with a CVi/NVi 1.5 T imager (General Electric Medical System, Milwaukee, WI) with a standard head coil.

RESULTS

In agreement with reported findings (4-6), we found globus pallidus and diffuse bilateral WM lesions on T2-weighted imaging, FLAIR and DWI. White matter lesions were increased during delayed neurologic defects suggesting progressive restricted diffusion. Unexpectedly, we observed qualitative asymmetrical patterns of bifrontal WM involvement in FAM of DTI images. Compared with DWI, these images showed a so-called DWI/DTI mismatch. Clinical outcome correlated more closely with DTI findings than with DWI images. Additional FAM values were significantly lower on right frontal than contralateral areas (mean FAM

was 0.15 on right, and 0.24 on left frontal WM). Total remission of symptoms was confirmed by normal FAM at the last MR imaging.

CONCLUSION

During follow-up DWI showed diffuse high intensity lesions in WM, and DTI revealed a focal asymmetrical decrease in FAM on frontal WM, which normalized at the last MR imaging. The mismatch between DWI and DTI in MR image correlated positively with the patient's clinical improvement. Such clinical and radiologic reversibility supports including DTI to glean additional information on the prognosis and evolution of patients with DNS after ACMP.

KEY WORDS: Delayed encephalopathy, monoxide poisoning, diffusion tensor image

Poster 27

Technical and Diagnostic Properties of T2-Weighted MR Imaging after the Application of Gd-DTPA in the Follow-Up of Patients with Multiple Sclerosis

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PURPOSE

To determine whether T2-weighted imaging of the brain can be performed after the administration of Gd-DTPA in the follow-up of patients with multiple sclerosis.

MATERIALS & METHODS

In 50 patients (16 patients with multiple sclerosis) T1- and T2-weighted MR imaging was performed before and after administration of Gd-DTPA (Magnevist, Schering, Berlin, Germany). The signal intensity in T2-weighted images was measured within cerebral lesions, in enhancing lesions, and in various anatomical locations. Additionally the pre and postcontrast series were evaluated quantitatively and qualitatively by two blinded readers. Finally the dependence of the signal intensity of a T2-weighted turbo spin-echo sequence of the Gd-DTPA concentration was simulated numerically.

RESULTS

No significant changes in signal intensities were observed neither in the gray nor the white matter. In 20 enhancing lesions a significant rise of signal intensity in the range of 4% ($p < 0.01$) was observed. Two experienced readers did not observe any significant differences between T2-weighted pre and postcontrast series in the counted number of lesions, the maximal diameter of the largest lesion and in the interpretation of images.

CONCLUSION

T2-weighted imaging performed prior to and after the administration of gadolinium provides similar information. The change of MR protocols with T2-weighted imaging acquired after the administration of gadolinium allows shorter examination time and assures sufficient time for contrast enhancement in cerebral lesions with a disrupted blood-brain barrier.

KEY WORDS: Multiple sclerosis, contrast agent, effectiveness

Poster 29

T1 and T2 Characterization in Mice Brain during Hyperoxia at High Magnetic Field

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PURPOSE

An increased concentration of dissolved oxygen in the blood causes a reduction in the T1 relaxation time that has been attributed to the molecular paramagnetism of oxygen. Although this T1 shortening has been reported in the lungs, abdominal organs and skeletal muscle, studies of the central nervous system are substantially sparse. On the other hand, it is known that the T2 value increases as the oxy-Hb content in blood increases (BOLD effect). The aims of this study were to characterize T1 and T2 changes in mice brain during hyperoxia at 9.4 T.

MATERIALS & METHODS

The experiments were carried out using wild-type mice. All experiments were performed on a 9.4 T MR system (Bruker). The mice inhaled either 100% oxygen (N = 8) or carbogen (N = 8). After SE images were obtained for T1 and T2 measurement over approximately 15 min, the room air was changed to either 100% oxygen or carbogen. Five minutes later, the same scan protocol was repeated. The regions of interest (ROIs) were placed on the cerebral cortex and pituitary gland to calculate the T1 and T2. Statistical analysis of the data was performed using paired Student's t-test.

RESULTS

During hyperoxia, the T1 value of the cerebral cortex significantly decreased in comparison with that under room air (100% oxygen: 11% decrease, $P < 0.05$ and carbogen: 9% decrease, $P < 0.05$), while there was no significant difference in the pituitary gland. No significant difference in %T1 changes was observed between the 100% oxygen and carbogen conditions. The T2 value of the cortex and pituitary gland, as compared with that under room air, significantly increased during exposure to either 100% oxygen (cortex: 3.7% increase, $P < 0.05$ and pituitary gland: 16.4% increase, $P < 0.001$) or carbogen (cortex: 5.4% increase, $P < 0.05$ and pituitary gland: 20.8% increase, $P < 0.001$). No significant difference in %T2 changes was observed between 100% oxygen and carbogen conditions.

CONCLUSION

Shortening of the T1 value during hyperoxia was demonstrated clearly. The increased dissolved oxygen may act as a dipole-dipole relaxation agent during hyperoxia. The changes in T1 were not significantly different between 100% oxygen and carbogen conditions. The reduced cerebral perfusion during inhalation of 100% oxygen may have little effect on T1. The pituitary gland receives blood flow from

the brain, in addition to receiving regular arterial blood supplies. A reduced concentration of dissolved oxygen might cause this insignificant T1 reduction in the pituitary gland. In the case of T2, the mechanism may be related to the conversion of deoxy-Hb to oxy-Hb, which may make the intracellular environment more diamagnetic (BOLD effect). Carbogen is known to have another effect that may alter the T2 value of the normal brain. Vasodilation increases the cerebral blood flow and blood volume, which may contribute to the observed prolongation of T2 during inhalation of carbogen. However, no significant difference in T2 was observed between the 100% oxygen and carbogen conditions. Therefore, our results suggest that at 9.4 T, the prolonged T2 during hyperoxia is caused mainly by increased BOLD effect rather than by increased cerebral blood flow and blood volume.

KEY WORDS: Mouse brain, hyperoxia, high magnetic field

Poster 30

Clinical Application of Proton MR Spectroscopy for Predicting the Prognosis in Patients with Depression

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PURPOSE

To assess the usefulness of MR spectroscopy (MRS) and MR images data for predicting the prognosis in a patient with geriatric depression.

MATERIALS & METHODS

From May 1999 to September 2002, we investigated 51 patients with depression in age ranging from 54 to 80 years, 25 men and 26 women. MR spectroscopy and MR imaging were performed on 1.5 T MR scanner (Signa; GE) using the point resolved echo spectroscopy sequence with the parameters of TR/TE = 2000/136 ms. A voxel with 2 cubic cm was located in frontal white matter. We also evaluated vasculopathic factors (VF) on T2-weighted images along the classification of Fazekas (1). In all patients, MR spectroscopy and MR imaging data were obtained before the initial administration of the therapeutic agents. The patients were classified into two groups based on the values of NAA/Cr ratios; Group A (NAA/Cr ratio ≥ 2.1) and Group B (NAA/Cr ratio < 2.1). The threshold was defined as one SD lower value than that of mean obtained from normal volunteers in same age group (N = 16). To assess the results of treatment for the patients, the standard psychiatric tests such as word fluency test 1 (animal test), word fluency test 2 (verbal test), and WAIS-R were done before and after medication. To clarify the difference of therapeutic response between the two groups, Student's t-test was performed in each examination.

RESULTS

Eighteen and the remaining 33 patients were in Group A (62.2 ± 6.5 years old) and Group B (63.8 ± 6.7 years old), respectively. No dementia or other major lesions were recognized in both groups. Before antidepressant medication, the mean NAA/Cr ratio was 2.35 ± 0.21 in Group A and 1.76 ± 0.33 in Group B, the mean scores of animal test in Group A and B were 16.8 ± 4.8 and 17.2 ± 4.2 respectively, those

of verbal test in Group A and B were 17.5 ± 5.6 and 17.3 ± 5.1 respectively, and those of WAIS-R in Group A and B were 26.3 ± 9.6 and 26.1 ± 9.3 respectively. After the medication, the mean score of animal test in Group A and B were 24.5 ± 6.3 and 17.6 ± 4.5 respectively ($P < 0.001$), those of verbal test in Group A and B were 24.6 ± 6.9 and 17.7 ± 6.5 respectively ($P < 0.005$), and those of WAIS-R in Group A and B were 46.4 ± 12.3 and 27.6 ± 11.9 respectively ($P < 0.001$). The sensitivity and specificity with NAA/Cr ratios were about 75% and about 90% respectively. The current results suggest that MRS data from frontal white matter may be used as a prognostic index for depressive psychosis patients. The difference of VF between group A and B also was statistically significant (A: 0.6 ± 0.3 , B: 1.3 ± 0.3 , $P < 0.001$). It is also suggestive that VF may be an important factor for the disease from the point of therapeutic effect.

CONCLUSION

Our data support that the depressive psychosis patients with high NAA/Cr ratios (> 2.1) tend to have a good response to medication or psychotherapy. The measurement of NAA/Cr ratio before treatment is useful for the prediction of prognosis in the depressive disease. Our data also suggest that ischemic change in deep white matter may be an unfavorable factor for the effective treatment of the disease.

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KEY WORDS: MR spectroscopy, depression, prognosis

Poster 31

Technique and Clinical Utility of CT and MR Perfusion in Current Practice

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PURPOSE

In this exhibit we will discuss the acquisition and postprocessing techniques involved in cranial MR and CT perfusion techniques. We will present specific cases where CT or MR perfusion provided useful clinical information.

MATERIALS & METHODS

Qualitative dynamic susceptibility contrast-enhanced MR perfusion techniques will be described including data acquisition and postprocessing techniques, which result in color maps of relative cerebral blood flow (rCBF), relative cerebral blood volume (rCBV), and relative mean transit time (rMTT). Quantitative whole brain MR perfusion parameters can be obtained utilizing a "bookends" technique, which will be described. Quantitative CBV measurements of hemispheric white matter are calculated by utilizing separate measurements of cerebral hemispheric white matter T1 with rapid true FISP pulse sequence measurements from which qCBF values can be obtained. Spin labeling MR perfusion flow measurements do not require gadolinium injection and instead "label" the flowing blood with a saturation pulse. We

also will discuss cranial CT perfusion acquisition and post-processing techniques including selection of an arterial input function.

RESULTS

Perfusion imaging techniques can offer valuable clinical information. In stroke patients, a penumbra of decreased perfusion around a central core of restricted diffusion can be identified and represents tissue that may be salvageable. Areas of chronic ischemia, such as in cases of carotid occlusion and moyamoya disease, can be studied to assess the status of collateral circulation. In these cases, perfusion studies offer the neurosurgeon information that can support the utility of an external carotid to internal carotid bypass. MR perfusion maps can demonstrate improved regional flow after successful intracranial stent placement or angioplasty. Perfusion parameters also are affected by rapid blood pressure changes, such as in cases of posterior reversible encephalopathy syndrome (PRES). Hypoperfusion relative to arterial vasospasm can be identified after subarachnoid hemorrhage and may become an important component of their management plan. A patient's vasodilatory capacity can be analyzed by the change in the rCBF after the administration of acetazolamide (Diamox). Additionally, CBV ratios may better characterize an intracranial mass and help narrow the differential diagnosis. Examples of these and other cases will help illustrate the growing clinical utility of CT and MR perfusion techniques.

CONCLUSION

CT and MR perfusion techniques can be helpful in management and clinical decision-making in a wide variety of disease processes affecting the brain. As the technology evolves, CT and MR perfusion likely will become an integral component of many imaging algorithms.

KEY WORDS: MR perfusion, CT perfusion

Poster 32

Multivoxel Proton Spectroscopy in Malformations of Cortical Development

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PURPOSE

To evaluate by multivoxel proton spectroscopy (1H-MRS) patients with malformations of cortical development (MCD).

MATERIALS & METHODS

We studied 28 patients presenting epilepsy with MCD. The MR imaging protocol included: sagittal T1-weighted imaging, axial inversion recovery imaging, coronal SPGR, coronal fluid-attenuated inversion recovery imaging, axial T2-weighted imaging and proton spectroscopy. Multivoxel proton spectroscopy was performed using PRESS technique on an axial slice exciting a large volume of interest (VOI) including the area with MCD. In each VOI, a smaller VOI of 2.25 cm³ centered on the MCD was selected to study N-acetyl-aspartate/creatine (NAA/CR), choline/creatine (CHO/CR) and N-acetyl-aspartate/choline (NAA/CHO)

ratios. In patients who presented with unilateral involvement in anatomical imaging, we studied the metabolite ratios in the apparently normal-appearing contralateral side. We also studied an age-matched control group (n = 30) with the same 1H-MRS protocol.

RESULTS

The MR images defined the type of MCD. Sixteen patients presented unilateral MCD, and in these the contralateral side also was studied. From the 29 analyzed VOIs with MCD: 15 were composed of gray matter heterotopia, 6 of cortical dysplasia, 3 VOIs of schizencephaly, 3 of polymicrogyria, and 2 of hemimegalencephaly. The 1H-MRS of both the MCD lesions and of the normal-appearing contralateral side in patients with unilateral involvement showed decreased NAA/CR and NAA/CHO ratios while CHO/CR ratio was normal when compared to the control group. The normal-appearing contralateral side in patients with unilateral involvement did not present statistical significant differences in the metabolite ratios in comparison to the MCD lesions.

Metabolites ratios obtained in the patients and control group according to their location

	NAA/CR	CHO/CR	NAA/CHO
Malformations of cortical development areas	1.70 ± 0.53	1.26 ± 0.33	1.46 ± 0.58
Contralateral side	1.76 ± 0.56	1.29 ± 0.42	1.44 ± 0.52
Control group	2.55 ± 0.35	1.26 ± 0.30	2.14 ± 0.58

CONCLUSION

Multivoxel proton spectroscopy showed abnormal metabolite ratios in both the MCD lesions and in the normal-appearing contralateral side in patients with unilateral MCD. These findings suggest a more diffuse cerebral involvement than detected by anatomical MR imaging. From a practical standpoint, in 1H-MRS studies of MCD, the contralateral normal-appearing side should not be used as a control.

KEY WORDS: MR imaging, multivoxel spectroscopy, malformations of cortical development

Poster 33

Differentiation of Tumor Recurrence from Radiation-Induced Necrosis Using Diffusion Tensor Imaging

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PURPOSE

To evaluate the ability of diffusion tensor imaging (DTI) in distinguishing between radiation necrosis and brain tumor recurrence in patients after radiotherapy.

MATERIALS & METHODS

We reviewed 16 patients (7 males, 9 females, 5-56 years old, mean age 35 years) who developed new contrast-enhancing lesions 3-36 months after radiation treatment of the original tumor. Histologic diagnoses of the original tumors in these 16 patients were astrocytic tumors (11 patients), metastases (3 patients), medulloblastoma (1 patient), and ependymoma (1 patient). The final differentiation between tumor recur-

rence and nonneoplastic necrosis of the new enhancing mass found after radiotherapy was decided based on either histologic findings or follow-up MR examinations and clinical conditions. In 4 patients who received histologic verification (by either surgical resection or stereotactic biopsy), there were 2 cases of tumor recurrence and 2 of radiation necrosis. In the remaining 12 patients who did not undergo surgical intervention, the lesions were considered to be nonneoplastic therapy-related changes if the enhanced lesions disappeared ($n = 3$) or decreased in size ($n = 2$) in subsequent MR examinations. Otherwise, tumor recurrence was entitled if the enhancing lesions increased extensively in size on follow-up serial MR examinations ($n = 5$), and the patient's clinical condition deteriorated progressively during that period ($n = 2$). In addition to routine T1-weighted, T2-weighted, FLAIR and, contrast-enhanced T1-weighted sequences, DTI was obtained using a single shot spin-echo EPI technique (9 directions, $b = 1000\text{s/mm}^2$). All examinations used a 1.5 T system with the manufacturer-supplied birdcage, quadrature head coil. Image postprocessing was performed to generate ADC and FA maps with vendor-provided software. The region of interest (ROI) was placed in solid part of the enhancing lesions according to contrast-enhancing T1 images and T2-weighted (b_0) images. ADC, FA values, and the standard deviation then were calculated. Two-sample t test was used for statistic analysis.

RESULTS

Apparent diffusion coefficient values for tumor recurrence (range = $1.16\text{--}1.29 \times 10^{-9}\text{mm}^2/\text{s}$, mean $\pm$ SD = 1.21 ± 0.12) were significantly higher ($p < 0.05$) than those for radiation-induced cerebral necrosis (range = $1.05\text{--}1.15 \times 10^{-9}\text{mm}^2/\text{s}$, mean $\pm$ SD = 1.10 ± 0.12). A decreased FA also was demonstrated in both groups related to normal white matter with ranges of 0.10–0.32 (mean $\pm$ SD = 0.19 ± 0.05) for tumor recurrence, and 0.15–0.5 (mean $\pm$ SD = 0.27 ± 0.06) for necrosis.

CONCLUSION

Our findings are consistent with previous reports (1, 2). The higher ADC values found in the areas of tumor recurrence may be due to micronecrotic changes in treated brain tissue in these patients. On the other hand, the lower ADC in radiation necrosis patients may be a result of scarred tissue that retards water movement. Decreased FA value in both groups can be explained by the destruction of white matter. However, this is not specific enough to distinguish the difference between tumor recurrence and necrotic change. Our initial results suggest that DTI potentially can provide a non-invasive means to distinguish between tumor recurrence and radiation necrosis.

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KEY WORDS: DTI, brain neoplasm, radiation-induced changes

Poster 34

Proton MR Spectroscopic Evidence for Functional Thalamic Involvement in Diabetic Neuropathy

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PURPOSE

Diabetic neuropathy (DN) is a common debilitating complication of diabetes mellitus. In fact, diabetes is the leading cause of nontraumatic lower limb amputations in the western world. Pathologic abnormalities of the peripheral nerves in DN have been well quantified. However, the extent of central nervous system involvement remains unresolved. A complete understanding of the full extent of nervous system involvement is crucial to elucidating the pathogenesis of DN and facilitates the development of rational treatments. This study uses proton MR spectroscopy (¹H-MRS) to determine the neurochemical constitutional make-up of deep gray matter in DN.

MATERIALS & METHODS

A total of 16 diabetic patients and 8 healthy volunteers (HV) have been studied to date. Following a detailed neurologic evaluation to stage the severity of DN (1), diabetic patients were divided into 2 groups. Group 1, 8 normal diabetics with no DN (No-DN) and group 2, 8 diabetics with established neuropathy (Est-DN). Volunteers were all right-handed males, matched for age and duration of diabetes. ¹H-MRS evaluation of the right posterior lateral thalamic nucleus was performed subsequently at 1.5 T (Eclipse, Philips Medical Systems). Proton spectra were obtained from a single voxel ($2 \times 2 \times 2\text{ cm}^3$) using short (STEAM: TE = 20 ms, TR = 300 ms) and long (PRESS: TE = 135 ms, TR = 1600 ms) echo-time techniques. Long TE results are expressed as ratios under the three prominent resonances: Choline (CHO), Creatine (Cr), and N-acetyl (NA) groups. Short TE results are expressed as the areas under the NA, Cho, Cr, and myo-inositol (mI) resonances relative to that of unsuppressed water.

RESULTS

In long TE sequence, mean NA:CHO ratio was significantly lower in EST-DN compared to the other 2 groups (Est-DN vs No-DN, $p = 0.036$; Est-DN vs HV, $p = 0.015$). There was no significant NA:CHO differences between No-DN and HV ($p = 0.596$). Normalized metabolite areas were not significantly different between the groups in the short TE sequence ($p > 0.05$).

CONCLUSION

The posterior lateral nucleus of the thalamus was chosen because most ascending sensory pathways relay within this nucleus before projections are sent to higher cortical centers. The first spectroscopy sequence, which acquired data at short, TE (20 ms) provides information regarding metabolite densities thereby reflecting metabolite concentrations. The second, at long TE (135 ms), yields information about relaxation rates of the neurochemical markers as well as their concentrations. Hence a reduction in NA resonance seen in long TE implies a change in neuronal physiology or function of the ascending sensory nerves in DN. The short TE results

suggest that this is not due to a lower mean concentration in the Est-DN group, which may in turn indicate that the neuronal damage is reversible. Further studies are required to determine if these changes occur early in the natural history of DN or if improved metabolic control can lead to direct neuronal improvement.

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KEY WORDS: Diabetic neuropathy, MRS, thalamus

Poster 35

Decreased Brain Activation in Patients with HIV Associated Dementia Measured by Functional MR Imaging

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PURPOSE

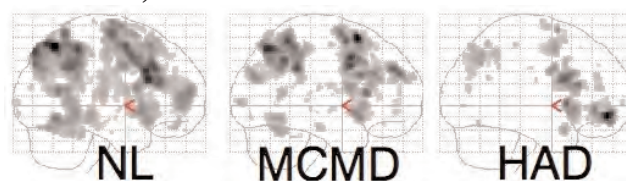
To determine if there are differences in brain activation that correlate with cognitive impairment in patients infected with the human immunodeficiency virus (HIV+) using functional MR imaging (fMRI).

MATERIALS & METHODS

Subjects: fMRI was performed on 25 HIV+ subjects who were clinically stratified into one of three cognitive classifications: normal cognitive function (NL), minor cognitive motor disorder (MCMD), or HIV-associated dementia (HAD) based on comprehensive neuropsychologic testing. **Image acquisition:** All studies were performed on a 3 T head imaging system, with transmit/receive head coil. MR images were acquired using a 2D T2*-weighted echo-planar imaging (EPI) sequence. A block design was used with 30-second activation and 30-second resting periods. The ON/OFF cycles were repeated four times. For response all subjects pushed a button on the response pad with the right hand. **fMRI paradigms:** The following paradigms were utilized: modified paced visual serial addition task (PASAT) (easy), modified PASAT (hard), attention, working memory, and motor function. **fMRI data processing:** The fMRI data were imported into the Statistical Parametric Mapping (SPM99, Wellcome Department of Cognitive Neurology, London, U.K.) software running on Matlab (Version 6.1, Mathworks, Inc. Natick, MA). The fMRI time-series images were motion-corrected using a least squares approach and a rigid body spatial transformation. A 3D spatial normalization was performed to fit the fMRI images to a standard reference space and spatial smoothing used a 5 x 5 x 5 mm FWHM Gaussian kernel. The results were displayed as a statistical parametric map depicting regional activations.

RESULTS

Figure 1 shows fMRI results from one memory task (serial addition hard).



These are group activation maps showing brain areas activated in the groups of HIV+ subjects with normal cognition (NL), and in groups classified as MCMD and HAD, for the serial addition task. Gray pixels indicate areas of brain activation with threshold of $t > 3.1$ for all maps. This illustrates a pattern of decrease in functional activation in MCMD and HAD subject groups. We found a similar pattern of decreased areas of activation in MCMD and HAD groups for all cognitive tests (serial addition easy and hard, working memory), and the attention and motor tasks.

CONCLUSION

The analysis of the fMRI data supports the hypothesis that there are differences in fMRI activation that correlate with cognitive impairment in HIV+ subjects. This leads us to speculate that there is a diffuse effect on fMRI. One possibility is that there is an effect of HIV on vascular reactivity or baseline blood flow, which alters the sensitivity of fMRI to detect cortical activation.

KEY WORDS: HIV, dementia, fMRI

Poster 36

A Surpiginous Hyposignal Gradient T2 Tract: The Gnathostoma's Migrating Trail

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PURPOSE

To evaluate the imaging patterns of CNS gnathostomiasis.

MATERIALS & METHODS

Retrospective analysis of CT and MR imaging of the brain and spine of 20 clinically proved cases of CNS gnathostomiasis (11 females and 8 males, age range 16-58 years old) performed at Ramathibodi Hospital with 1.5 T magnet and multidetector CT from November 26, 1991 to September 9, 2002 was done. The study was composed of 4 CT and 15 MR images of the brain, 3 MR images of the orbits, 9 MR images of the spine, 1 cerebral and 1 spinal angiogram. Spin-echo T1-weighted, PD/T2-weighted and gradient T2-weighted pulse sequences were performed in all cases.

RESULTS

Randomly distributed recent intracranial and intrathecal hemorrhage of varying size and shape were found in 16 cases (42.11%). They were composed of 3 subarachnoid hemorrhage (SAH) (7.89%), 4 subdural hemorrhage (10.53%), 6 intraparenchymal hemorrhage (15.79%), and 4 hematomyelia (7.89%) without associated tumor nor abnormal vessels. Moderate leptomeningeal enhancement was

found in 1 case (2.63%) in 2 consecutive CT scans of the brain representing eosinophilic meningitis. Follow-up MR imaging in this case demonstrated multiple scattered hyposignal gradient T2 foci throughout the brain. Encephalomalacia with old blood product was found in 2 cases (5.26%) with known intracranial gnathostomiasis several years ago. Thin surpiginous hyposignal gradient T2 tracts (Figures A and B) were found in 13 cases (34.21%). They were composed of 9 brain (23.68%) and 4 spinal cord (10.53%). Ill-defined hypersignal T2 change in the cord without associated blood product was seen in 3 cases (7.89%). There were three other findings (7.89%), composed of thick dural enhancement with prominent epidural vascularity around midthoracic cord and bilateral pleural effusion in the patient with eosinophilic meningitis and transient migratory pain along left side of body and chest. The other finding was left periorbital swelling (2.63%) in the patient with scattered intracranial hemorrhage and surpiginous hyposignal gradient T2 tracts.

Table: Summary of imaging findings in CNS gnathostomiasis

Imaging Findings	No.	%
Intracranial hemorrhage	13	34.21
-SAH	3	7.89
-subdural hemorrhage	4	10.53
- cerebral hemorrhage	6	15.79
Hematomyelia	3	7.89
Hypersignal T2 change in the cord without associated blood product	3	7.89
Eosinophilic meningitis	1	2.63
Encephalomalacia	2	5.26
Others	3	7.89
-adjacent dural enhancement	1	2.63
- periorbital soft tissue swelling	1	2.63
- bilateral pleural effusion	1	2.63
Total	38	100

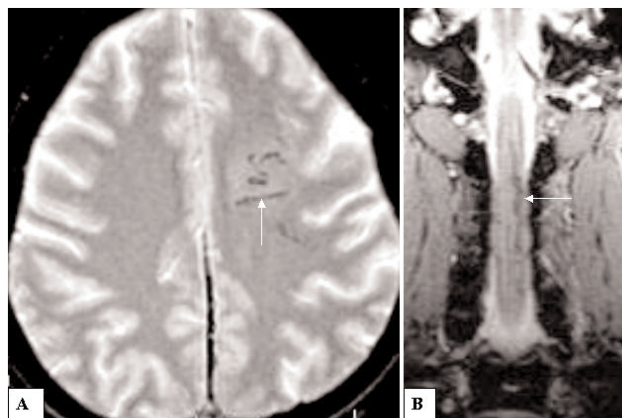


Figure: Surpiginous hyposignal gradient T2 parasitic migrating tracts are demonstrated in the left centrum semiovale (A) and along the left lateral cervical cord (B)

CONCLUSION

Randomly distributed intracranial hemorrhage and hematomyelia of varying size and shape without associated abnormal vessels nor enhancement are the most common findings in CNS gnathostomiasis followed by thin surpiginous hyposignal gradient T2 tract which represents the most characteristic diagnostic feature of parasitic migrating tract. Eosinophilic meningitis can be seen when only subarachnoid space is invaded. Encephalomalacia with associated old blood product is the late result of intracranial hemorrhage.

Pleural effusion and periorbital swelling can be found associated with adjacent spinal and cerebral migrating tract respectively.

KEY WORDS: Gnathostomiasis, CNS, migrating

Poster 37

Initial and Follow-Up Diffusion-Weighted MR Imaging Findings of Herpes Simplex Type 1 Encephalitis

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PURPOSE

Herpes simplex virus type 1 (HSV) is the most common cause of viral encephalitis in adults. MR imaging contributes to early diagnosis with the earliest imaging findings on fluid attenuated inversion recovery (FLAIR) images 48 hours after the onset of symptoms. The results from the recent studies have raised hope that diffusion-weighted MR imaging (DWI) may be more sensitive in early detection of HSV encephalitis. On DWI two distinct types of findings are described in HSV-1 encephalitis: lesions similar to cytotoxic edema, and lesions similar to vasogenic edema. The goal of this study was to determine (a) the value of diffusion-weighted MR imaging in early detection of HSV encephalitis, (2) changes of DWI findings under therapy, (3) if there is a correlation between the DWI abnormalities and outcome of the disease.

MATERIALS & METHODS

Conventional MR imaging including T1- and T2-weighted, FLAIR, and DWI were performed in 6 patients with proven HSV encephalitis. Qualitative and quantitative analysis of the signal abnormalities DWI was performed on the initial studies and in all follow-up studies in all patients. Apparent diffusion coefficient (ADC) values from the abnormal and contralateral normal-appearing brain white matter were calculated. Neurologic signs and symptoms and laboratory parameters were documented and correlated with imaging findings.

RESULTS

Patients ages ranged from 25-65 years. Two patients had 4, 1 patient had 3, and 3 patient had 2 MR studies. On initial MR imaging the majority of the lesions showed high signal on DWI, and low ADC values (mean 0.72×10^{-3} mm/sec, mean ratio 0.8) indicating restricted diffusion. All lesions were hyperintense on FLAIR and T2-weighted MR images. On first follow-up MR examination (mean 2 weeks later) an increase in ADC was observed (mean 0.95×10^{-3} mm/sec). Leukomalacia and atrophic changes were present on late follow-up studies with further increase in ADC (mean 7.26×10^{-3} mm/sec) representing irreversible tissue changes. Only one lesion (insular cortex) showed increased ADC value (1.29×10^{-3} mm/sec) suggesting vasogenic edema. On first (17 days) and all subsequent follow-up MR scans the lesion was isointense on DWI with decrease of ADC value (1.02×10^{-3} mm/sec and 0.8×10^{-3} mm/sec) and lesion/normal-appearing white matter ratio of 1. Diffusion-weighted MR imaging

was equal to FLAIR imaging in 5 patients, in one patient DWI clearly showed abnormalities, whereas FLAIR showed no changes.

CONCLUSION

Our results suggest that DWI is a sensitive method for the early detection of HSV encephalitis. Calculation of ADC can distinguish between cytotoxic and vasogenic edema and furthermore to be prognostic. Areas of restricted diffusion most likely represent irreversible changes which evolve in leukomalacia and atrophy. Areas of vasogenic edema are reversible and normalize without tissue changes. More studies in hyperacute phase should be preformed to clarify the ability of DWI to detect abnormalities in HSV encephalitis earlier.

KEY WORDS: Herpes simplex virus, MR imaging, diffusion-weighted imaging

Poster 38

Imaging of Neurologic Manifestations of HIV

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PURPOSE

To highlight the spectrum of neuroimaging findings in seropositive HIV patients with neuropsychiatric manifestations in India. To identify some radiologic clues in neuroimaging favoring a particular diagnosis and to present these in a pictorial format.

MATERIALS & METHODS

This is a retrospective study of 122 seropositive HIV patients with neuropsychiatric manifestations admitted in our "tertiary care hospital" during the period of 3 years (2000-2002). Thirty-four had insufficient pathologic confirmation and hence were excluded and so the results refer to remaining 88 cases, where the diagnosis was confirmed by biopsy (39 cases) and/or autopsy reports (55 cases). It includes review of their clinical data and imaging findings, spiral CT in 78 (69 contrast) and 0.5 T MR imaging in 61 (28 contrast). Their number, site, extent, morphology, and coexistent findings were studied and the representative images are shown.

RESULTS

In our series of 88 patients, tuberculosis (37cases) was the most common - tuberculoma was seen in 24/37 cases (findings of T2-weighted shortening and enhancement in 83%), tuberculous abscesses in 10/37 cases (which were multiloculated and > 3 cm in 80%), communicating hydrocephalus in 18/37cases and infarction in 12/37cases (83% in basal ganglia). In toxoplasmosis (11 cases) 82% cases showed multiple lesions with 91% having at least one lesion in basal ganglia. Ninety-one percent lesions were hypodense with ring enhancement and mass effect on CT. Classical target-shaped lesions on T2-weighted MR imaging were seen in 41% only. In PML (12 cases) multifocal, hypodense, nonenhancing lesions were seen in 83% cases on CT. T2-weighted hyperintensity was seen in 91% cases. CNS lymphoma (9 cases) was hypodense on plain CT and showed fast contrast enhancement on CT in 89% cases. T1-weighted hyperinten-

sity with hypointense rim was seen in 89% cases; common sites being paraventricular and corpus callosum. In HIV encephalopathy (19 cases) 63% cases showed "dirty white matter lesions" on T2-weighted MR imaging. Eighty-four percent showed diffuse cerebral atrophy and 42% had coexistent opportunistic infections further complicating diagnosis.

CONCLUSION

In a developing country like India our study on neurologic manifestations of HIV, tuberculosis was found to be most prevalent (42%); prevalence of others being encephalopathy (21.5%), PML (14%), toxoplasmosis (12.5%), and lymphoma (10%). Radiologic clues such as multiplicity, location, patterns of enhancement, and white matter changes helped to differentiate between neoplastic, inflammatory, and infectious lesions and will be displayed in the visual presentation.

KEY WORDS: HIV neuroimaging

Poster 39

Brain Abscess and Necrotic Brain Tumor: Discrimination with Perfusion- and Diffusion-Weighted MR Imaging

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PURPOSE

The differential diagnosis between brain abscesses and necrotic tumors such as glioblastomas and metastases often is difficult to establish by conventional MR imaging. The goal of our study was to evaluate the ability of perfusion- and diffusion-weighted (DW) MR imaging to differentiate between these pathologies.

MATERIALS & METHODS

MR imaging was performed in 18 patients with cystic brain lesions (4 abscesses, 6 glioblastomas, 2 anaplastic astrocytoma, 6 metastases). In addition to standard MR sequences, trace DW imaging, apparent diffusion coefficient (ADC) map were performed. Perfusion MR imaging was performed by using a first-pass gadopentate dimeglumine T2*-weighted gradient-echo single-shot echo-planar sequence. Relative cerebral blood volume (rCBV) was calculated for all lesions.

RESULTS

The central portion of all 6 metastases and 7 of 8 high-grade gliomas showed unrestricted diffusion, whereas all 4 abscesses showed restricted diffusion (low ADC values). However, restricted diffusion also was found in one glioblastoma. The ADC values calculated in patients with abscess (mean $\pm$ SD; $0.69 \pm 0.05 \times 10^{-3} \text{ mm}^2/\text{s}$) were significantly lower than those measured in patients with necrotic tumors ($2.36 \pm 0.63 \times 10^{-3} \text{ mm}^2/\text{s}$; $p < 0.001$). The measured rCBV in abscess, high-grade glioma and metastases were 0.76 ± 0.12 (mean $\pm$ SD), 5.51 ± 2.08 , and 4.66 ± 2.39 , respectively. The difference between abscess and necrotic tumors was statistically significant ($p < .001$).

CONCLUSION

Diffusion-weighted imaging is useful for both identifying brain abscesses and differentiating them from cystic brain tumors. However for intermediate lesions in which diffusion MR findings can be misleading, perfusion MR imaging seems to be a promising method.

KEY WORDS: Abscess, necrotic tumor, diffusion MR imaging

Poster 40

Diffusion-Weighted Imaging and Apparent Diffusion Coefficient Values of Intracranial Tuberculomas and Tuberculous Abscesses

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PURPOSE

To describe the MR diffusion-weighted imaging (DWI) features of intracranial tuberculomas and tuberculous abscesses, and to compare their apparent diffusion coefficient (ADC) values with other intracranial mass lesions including gliomas, metastases, and pyogenic and fungal abscesses.

MATERIALS & METHODS

MR imaging of nine patients (4 males, 5 females, age range 22-56 years) with clinical and pathologic diagnosis of intracranial tuberculomas and/or abscesses were evaluated. A total of 114 tuberculomas and 7 tuberculous abscesses were evaluated. The routine MR and isotropic DWI features, as well as ADC values were compared with gliomas (n = 10), metastases (n = 30), pyogenic abscesses (n = 20), and fungal abscesses (n = 2).

RESULTS

Four patients had both tuberculomas and tuberculous abscesses, and 4 had coexisting tuberculous basal meningitis. The tuberculomas were variable on isotropic DWI with solid and necrotic areas appearing bright and dark respectively. Most of them demonstrated a characteristic peripheral bright rim. The mean ADC values of the solid, necrotic, and rim areas were 0.76, 2.2, and 1.2 respectively. Tuberculous abscesses appeared bright on DWI with a mean ADC value of 0.41. The mean ADC values of gliomas, metastases, and pyogenic and fungal abscesses were 2.2, 2.4, 0.54, and 0.67 respectively.

CONCLUSION

Tuberculomas have a variable appearance on DWI. The mean ADC value of the solid component of tuberculomas appears to be lower as compared to solid masses like gliomas and metastases, and therefore may be useful in differentiating them. The tuberculous abscesses show similar ADC values as those of pyogenic and fungal abscesses.

KEY WORDS: Tuberculoma, diffusion imaging, abscess

Poster 41

Evaluation of Postoperative Intracranial Empyemas and Subcutaneous Abscesses with Diffusion-Weighted Images

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PURPOSE

Diffusion-weighted images (DWI) are useful for diagnosis of brain abscesses. However, there are no systematic reports that evaluate the findings of DWI for postoperative intracranial infections. The purpose of this study was to evaluate postoperative intracranial empyemas with or without subcutaneous abscesses with DWI.

MATERIALS & METHODS

Conventional MR images and diffusion-weighted images in six patients with epidural or subdural empyemas with or without subcutaneous abscesses after surgery were reviewed retrospectively. Two radiologists evaluated signal intensities of the lesions on DWI. Apparent diffusion coefficients (ADCs) were measured in each lesion.

RESULTS

The inflammatory lesions included epidural empyemas in four, subdural empyemas in two, and subcutaneous abscesses in two. In six empyemas, the signal intensity on DWI was hyperintense to the brain in two, iso to slightly hyperintense in three, and isointense in one. The subcutaneous abscesses were hyperintense and isointense in one each. The ADC values ranged from 0.6 to 2.5 (mean, 1.5 ± 0.6).

CONCLUSION

Postoperative intracranial epidural empyemas and subcutaneous abscesses had various signal intensities and a wide range of ADCs on DWI. This variability should be recognized when evaluating DWI in patients with suspected intracranial infections after neurosurgery.

KEY WORDS: Infectious diseases, DWI

Poster 42

Distinguishing of High-Grade Gliomas from Metastases with Perfusion-Weighted MR Imaging

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PURPOSE

Intracranial metastases and high-grade gliomas are two common brain tumors with different management and different outcomes. We evaluated the role of perfusion-weighted MR imaging in the differential diagnosis of high-grade gliomas and metastases.

MATERIALS & METHODS

This study included 48 patients with brain tumors: 22 with high-grade gliomas and 26 with metastases (lung carcinoma 16, breast carcinoma 4, renal carcinoma 4, colorectal carcinoma 1, unknown primary site 1). MR imaging was performed by using a first-pass gadopentetate dimeglumine T2*-weighted gradient-echo single-shot echo-planar (1972/52) sequence followed by conventional imaging. The CBV maps were obtained for each patient. The relative CBV (rCBV) of the lesions was calculated from the intratumoral and peritumoral area by comparing with the normal white matter. Peritumoral area was defined to be within a 1-2 cm distance from the outer enhancing tumor margin. Region of interest size was 1-5 mm in diameter (depending on the size of the lesion) and was placed based on the color map. Results obtained from intratumoral and peritumoral areas of metastases and high-grade gliomas were compared with Student's t-test. A *P* value of less than 0.05 indicated a statistically significant difference.

RESULTS

The intratumoral rCBV ratios in the intratumoral region were measured 6.50 ± 4.29 for high-grade gliomas and 5.28 ± 2.91 for metastases. No statistically significant difference was found between high-grade gliomas and all metastases (*p* = 0.245). The measured rCBV in the peritumoral region in high-grade gliomas and metastases were 0.86 ± 0.20 and 0.41 ± 0.17 , respectively. The difference between this pathologies was statistically significant (*p* < 0.001).

CONCLUSION

Perfusion-weighted MR imaging provides additional information on the vascularity of these lesions, which is not available with conventional MR imaging. The measured intratumoral rCBV ratios could not be used to differentiate these two type tumors. However, peritumoral rCBV measurements can be useful in differentiating metastatic tumors from the high-grade gliomas.

KEY WORDS: MR imaging, metastases, perfusion imaging

Poster 43

MR Spectroscopy for Brain Tumors

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PURPOSE

The purpose of this study is to evaluate the effectiveness of MR spectroscopy (MRS) in differentiating benign from malignant brain neoplasms as well as in differentiating recurrent/residual neoplasm from postradiation changes. Primary and metastatic brain tumors are evaluated as well as posttherapy enhancing brain lesions.

MATERIALS & METHODS

Nearly 300 cases over the past 5 years were reviewed. Single and multivoxel MR spectroscopy was performed with TE = 135 and TR = 1500. The images were obtained with a 1.5 T superconducting Siemens magnet. Included patients had primary or metastatic brain tumors or postradiation enhancing brain lesions. Primary brain tumors included astrocytomas

(anaplastic astrocytomas and glioblastoma multiforme), meningiomas (benign and malignant), lymphomas, and dysgerminomas.

RESULTS

A malignant lesion can be diagnosed with confidence when the choline to creatinine ratio is greater than 1.6. In fact, the higher the choline:creatinine ratio, the greater the malignant potential of the tumor. Elevated lactic acid is a nonspecific finding, seen in both malignant processes and postradiation necrosis.

CONCLUSION

MR spectroscopy is a useful modality to help differentiate benign from malignant brain neoplasms and has a role in grading the malignancy of a tumor. More importantly, MRS is helpful in differentiating postradiation necrosis from residual tumor/tumor recurrence.

KEY WORDS: MR spectroscopy, brain neoplasms, radiation tumor necrosis

Poster 44

Postcontrast Fluid-Attenuated Inversion Recovery vs T1-Weighted Spin-Echo Imaging in the Evaluation of Intracranial Meningiomas

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PURPOSE

Although T1-weighted spin-echo (SE) sequences are used for contrast-enhanced imaging, fluid-attenuated inversion recovery (FLAIR) with its mild T1 effect also has been reported to be valuable in detecting a variety of brain lesions after gadopentetate dimeglumine injection. The aim of this study was to evaluate the enhancement patterns of intracranial meningiomas on postcontrast FLAIR images and compare them with SE images.

MATERIALS & METHODS

Twenty patients with thirty-five intracranial meningiomas were included in this study. Patient informed consent and institutional review board approval was obtained for the study. Fluid-attenuated inversion recovery and SE T1-weighted images were obtained before and after intravenous administration of gadopentetate dimeglumine in the axial plane. Postcontrast FLAIR images were compared with postcontrast T1-weighted images for the lesion conspicuity; the number of lesions detected, the contrast enhancement degree, the contrast enhancement pattern, and the detection of the dural tail sign. Two neuroradiologists reviewed the images independently in one sitting and reached a consensus for all patients.

RESULTS

The same number of lesions were detected on T1-weighted and FLAIR images. Lesion enhancement degree on FLAIR was equal or lesser than T1-weighted images for all meningiomas. Among 35 meningiomas 29 (83%) enhanced homogeneously, 2 (6%) inhomogeneously and 4 (11%) peripherally on T1-weighted SE images. On contrast-enhanced

FLAIR images, of the total 35 meningiomas 18 (51%) enhanced homogeneously, 6 (17%) inhomogeneously, whereas 11 (31%) meningiomas showed a bright peripheral rim enhancement not observed on T1-weighted images. Of the 11 meningiomas showing rim enhancement on FLAIR images 8 (73%) were measured to be 2 cm or more in diameter. Dural tail sign was found to be positive in 10 (29%) meningiomas on T1-weighted images and in 18 (51%) meningiomas on FLAIR images.

CONCLUSION

Although the enhancement degree of meningiomas on contrast-enhanced FLAIR images appear to be equal or inferior compared to T1-weighted SE images, the more readily detected dural tail sign and the peripheral contrast enhancement pattern detected on the former technique can be helpful in differentiating these lesions from other extraaxial masses. Therefore postcontrast FLAIR sequence can be used as a valuable adjunct to the postcontrast T1-weighted imaging in the evaluation of intracranial meningiomas.

KEY WORDS: Meningioma, FLAIR, contrast

Poster 45

Brain Tumor Segmentation with Diffusion Tensor Anisotropy

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PURPOSE

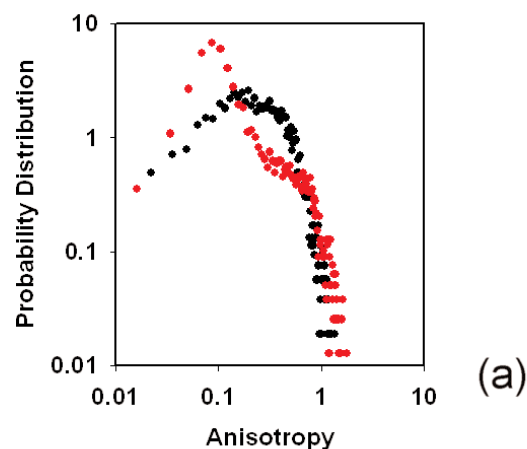
The present work exploits diffusion tensor anisotropy differences between neoplastic tissue and white matter fibers to separate the active portion of the tumor and necrotic tissue from unaffected tissue. Previous work (1) had demonstrated that the segmentation of the tumor is possible by integration of in vivo spectroscopy information with relaxation data, but in some cases the discrimination between the peripheral edematous region and the tumor itself is rather difficult to perform. On the other hand, diffusion tensor anisotropy is not as modified in the edematous tissue as it is in the tumoral or necrotic tissue, and in consequence it can be used as a good discrimination parameter which combined to other information related to the diffusion tensor such as its trace could give relevant parameters for a suitable segmentation of the tumor image.

MATERIALS & METHODS

Diffusion-weighted images were obtained for b-parameter ranging from 0 to 1350 s/mm², for three different gradient directions, on a Siemens Magnetom Sonata working at a magnetic field of 1.5 T. The images were analyzed with a specially designed program that performs an Inverse Laplace Transform of the diffusion-attenuated data and calculates the diffusion tensor anisotropy distribution with a suitable definition applicable for a partial determination of the diffusion tensor, i.e., using only three orthogonal directions of the field gradient. Finally, the program performs the segmentation of the image based on the trace of the diffusion tensor and its anisotropy.

RESULTS

The diffusion tensor anisotropy distributions are shown in Figure (a) corresponding to a region including the lesion indicated by red dots and to a separate region of unaffected tissue indicated by black dots. As can be seen in Figure (a) both distributions share common components except for the low anisotropy component exhibited by the tumor itself. The combination of the anisotropy information with the diffusion tensor trace information (both obtained from the same set of diffusion-weighted images) used to perform the segmentation of the tumor is shown in Figure (b). Light gray zones correspond to the tumor, while dark gray and gray zones correspond to liquid (or necrotic tissue) and unaffected tissue, respectively.



CONCLUSION

The methodology presented in this work clearly segments brain tumor images with appropriate spatial resolution for therapeutic needs, and overcomes the lack of discrimination between edematous and tumoral tissues as obtained by relaxation techniques. This result suggests the convenience of the combined use of both techniques to assess a confident segmentation of the tumor image.

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KEY WORDS: Segmentation, diffusion tensor, anisotropy

Poster 46

Anatomical and Metabolic Imaging of Primary Central Nervous System Amyloidoma

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PURPOSE

To demonstrate the anatomical and metabolic imaging of primary focal central nervous system (CNS) amyloidoma and to review these findings compared to the few cases previously described.

MATERIALS & METHODS

A 46-year-old woman presented with intermittent focal seizures and was found to have a lesion in the right frontal region. This lesion was evaluated preoperatively with CT, MR imaging, positron emission tomography with fluoro-2-deoxyglucose (FDG-PET) and MR spectroscopy (MRS). A stereotactic biopsy of the lesion confirmed primary CNS amyloidoma. Eighteen previous reports of primary focal intraparenchymal CNS amyloidoma were reviewed. Eleven of these reported CT findings, six of these eleven reported MR studies and no cases reported FDG-PET or MRS.

RESULTS

Noncontrast CT demonstrated a hyperdense lesion in the right posterior frontal region with probable involvement of the upper right internal capsule and no significant mass effect. Multiple small calcifications were seen. Calcification was described specifically in only one of 11 cases reported. On MR imaging the lesion was noted to be hyperintense on long TR sequences. The MR imaging is consistent with variable T2 characteristics reported of an intraparenchymal amyloidoma. Gadolinium administration resulted in faint, patchy enhancement. Out of the six cases that gave long TR results three reported the lesion to be hypointense, two mixed, one hyperintense, and five had intense enhancement. Utilizing proton MRS in the hyperintense area in the left frontal white matter increased choline with greatly decreased N-acetylaspartate (NAA) level, an increased choline-to-NAA ratio and an increased glutamate + glutamine (GLX) level was demonstrated. We interpreted these findings to be consistent with lymphoma. The FDG-PET scan demonstrated no evidence of abnormal uptake in or around the lesion.

CONCLUSION

Primary focal CNS amyloidoma is a rare entity with only 18 other cases reported in the literature. This is the first case to describe the metabolic and anatomical characteristics of a biopsy proven CNS amyloidoma. This information increases our understanding of the nature of this lesion and may assist in its diagnostic evaluation.

KEY WORDS: Amyloidoma, intraparenchyma, spectroscopy

Poster 47

Usefulness of Calculated Apparent Diffusion Coefficients in Differentiation and Grading of Common Brain Tumors

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PURPOSE

Apparent diffusion coefficients (ADC) calculation had some benefits about tumor grading and differentiation (1, 2). We evaluated the hypothesis that ADC calculation can improve the diagnostic efficacy of MR imaging in patients with brain tumor. The main purposes were as the follows: 1) to calculate ADC values from tumoral and peritumoral region in the differentiation (benign vs malign) and grading (low or high) of tumor types; 2) to evaluate the ADC values to distinguish the pathologic subtypes.

MATERIALS & METHODS

One hundred nine lesions in 83 patients with histologically proven brain tumors were evaluated prospectively by contrast-enhanced MR imaging and isotropic, echo-planar diffusion-weighted imaging ($b = 0, 500, 1000 \text{ s/mm}^2$) before the surgical procedure. For statistical purposes tumors were divided as benign (16 meningiomas, 10 tuberculomas, five dysembryoplastic neuroepithelial tumors and five epidermoid tumors), low grade (24 low grade astrocytomas, nine nonastrocytic gliomas) and high grade (25 metastases and 15 high grade astrocytomas) malign tumors. Tumoral and peritumoral ADC values were calculated for comparison and expressed in $10^{-3} \text{ mm}^2/\text{s}$. Data were analyzed with ANOVA and Student's t-tests among the tumor groups comparing benign vs malign, low grade vs high grade and different tumor types. Mann-Whitney U test and a nondirectional Scheffe post hoc procedures by 95 % confidence interval were employed where appropriate to correct for the effect of multiple comparisons. The mean difference was significant at the 0.05 level.

RESULTS

Tumoral and peritumoral ADC calculation easily can differentiate benign (109.06 ± 8.34 and 88.36 ± 19.12) tumors from malign (98.16 ± 19.94 and 146.36 ± 31.43) ones ($p < .05$ and $p < .001$ respectively). Tumoral and peritumoral ADC calculations were quite effective in grading of tumors as low (114.05 ± 14.50 and 157.39 ± 32.23), high (85.06 ± 13.11 and 138.31 ± 28.65) grade ($p < .000$) malign and benign ($p < .000$) but distinguishing low grade malign tumors from benign ones was only possible by peritumoral ADC calculation. In the differentiation of high grade astrocytomas (90.25 ± 9.89 and 128.63 ± 24.07) from metastasis (81.94 ± 13.97 and 142.96 ± 29.94), tumoral and peritumoral ADC calculations were not useful. In the differentiation of low grade astrocytomas (117.44 ± 15.62 and 169.77 ± 31.07) from low grade nonastrocytic gliomas (106.25 ± 7.34 and 136.35 ± 22.43), tumoral and peritumoral ADC calculations had statistically significant values ($p < .05$). Differentiation of meningiomas (108.69 ± 6.27) from tuberculomas (100.90 ± 4.95) ($p < .05$) was only possible by tumoral ADC calculation.

CONCLUSION

Apparent diffusion coefficient values of different tumor types, which reflect the restricted diffusion of protons due to alterations in the structure and cellularity, had more additional information to conventional contrast-enhanced MR imaging in the differentiation and grading of brain tumors. Higher peritumoral and lower tumoral ADC values were consistent with higher tumor grade and visa versa. Benign and low grade tumors can be differentiated only from each other by peritumoral ADC values.

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KEY WORDS: Brain neoplasm, brain diffusion, MR imaging

Poster 48

Diagnostic Value of Contrast-Enhanced Fluid-Attenuated Inversion Recovery Sequence in Intracranial Metastases

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PURPOSE

Postcontrast fluid-attenuated inversion recovery (FLAIR) imaging has been reported previously to be an efficacious method for the diagnosis of parenchymal and leptomeningeal metastases with a limited number of patients. Our purpose was to compare postcontrast T1-weighted and FLAIR images in depicting intracranial metastases with a larger patient group.

MATERIALS & METHODS

Sixty-nine patients with known primary malignancy and clinical suspicion of cranial metastases were studied. Axial FLAIR and spin-echo T1-weighted images were obtained before and after intravenous administration of gadopentetate dimeglumine. Postcontrast FLAIR images were compared with postcontrast T1-weighted images for the lesion conspicuity, the contrast enhancement degree, the number of lesions for parenchymal metastases, and the extension of the lesions for leptomeningeal-cisternal metastases.

RESULTS

Parenchymal metastases were demonstrated in 33 patients. Postcontrast FLAIR images showed more parenchymal metastases in five patients while equal number of lesions in 20 and less lesions in eight patients. Comparing the conspicuity of parenchymal metastases, contrast-enhanced FLAIR imaging was superior in five patients, equal in one, and inferior in 27 of 33 patients. The contrast enhancement degree was superior on postcontrast FLAIR sequence in five

patients, equal in the other five, and inferior in 23 of 33 patients. In the number, conspicuity and contrast enhancement degree of the lesions, postcontrast FLAIR sequence was superior to postcontrast T1-weighted images in the same five patients, and in all these patients, postcontrast FLAIR imaging was obtained as the second contrast-enhanced sequence. There were 11 patients with leptomeningeal-cisternal metastases, and the conspicuity, extension, and contrast enhancement degree of the lesions were superior on postcontrast FLAIR sequence in eight of 11 patients. In five of eight patients, FLAIR was obtained as the second postcontrast sequence. There were four patients with cranial nerve metastases, and postcontrast FLAIR sequence surpassed the contrast-enhanced T1-weighted imaging in the conspicuity and extension of the lesions in three of four patients. In two of these three patients, FLAIR was the second postcontrast sequence.

CONCLUSION

Postcontrast FLAIR sequence is a valuable adjunct to the postcontrast T1-weighted imaging, and use of FLAIR imaging routinely before and after the administration of contrast material is very efficacious in the delineation of parenchymal, and particularly leptomeningeal-cisternal and cranial nerve metastases.

KEY WORDS: MR imaging, FLAIR, cranial metastases

Poster 49

Diagnostic Accuracy and Complications of CT-Guided Brain Biopsy

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PURPOSE

The stereotactic brain biopsy approach was described by Clark in 1920 and was implemented in 1947 by Spiegel and Wicis. In 1948 Lars Leksell designed the system which carries his name. Before the use of CT, stereotactic measurements were taken by pneumo and angiography. CT helped to localize the lesion in a rapid fashion for both the patient and radiologist. MR imaging is a potentially useful method as well, but needs further improvements. Any surgical approach carries its risks; nowadays hemorrhage is the most frequent complication for CT-guided biopsy. To assess the diagnostic accuracy, neuroradiologic-pathologic agreement, and complications of CT-guided brain biopsies.

MATERIALS & METHODS

One hundred forty-seven patients undergoing CT-guided biopsy from 90-102 were reviewed. Selection criteria were: high surgical risk masses, and tumoral or nontumoral lesions subject of medical treatment. Barcia® and Leksell® guides and a Toshiba 300, Somatom DR2, and Somatom Plus 4 (Siemens) CTs were used. Parallel axial images to the stereotactic frame were obtained. Software provided both "X" and "Y" target axes, while "Z" was calculated by trigonometry.

RESULTS

One hundred twenty-five of 147 were positive biopsies (89 glioma, 14 lymphoma, 11 LMP, 4 metastasis, 2 pinealoma, 2 craniofaringioma, 1 toxoplasmosis, 1 ganglioglioma, 1 ischemic necrosis, and 1 abscess). Twenty-one of 147 biopsies were negative (9 normal brain tissue, 6 necrosis, and 6 gliosis). Complications were present in 15/147 cases: 11 hematoma (3 died), 1 infection, 1 edema, 1 seizure, and 1 recovered palsy. Morbidity was 15/147 (10.2%) and mortality 3/147 (2%). Bleeding cases (11) were produced in following diagnosis: 7 glioma III-IV, 2 LMP, and 1 metastasis. All death causes were due to bleeding. Agreement between radiologic and pathologic diagnosis was present in 107/125 cases (85.6%).

CONCLUSION

Diagnostic accuracy of CT-guided biopsy was 85%. Neuroradiologic-pathologic agreement was 85.6%. CT-guided biopsy carried a 10% morbidity and 2% mortality.

KEY WORDS: CT, stereotaxia, complications

Poster 50**MR Findings of Primary Central Nervous System T-Cell Lymphoma Including Perfusion MR Imaging**

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PURPOSE

To describe the MR findings of primary central nervous system T-cell lymphoma (T-PCNSL) and determine the utility of perfusion MR in the differential diagnosis.

MATERIALS & METHODS

Seven patients with pathologically proven T-PCNSL by using both immunohistochemical stainings and molecular studies were included in our study. The location, shape, enhancement, and signal intensity of the tumor were determined. The relative cerebral blood volume (rCBV) was analyzed both visually and quantitatively between the tumor and contralateral white matter in two cases.

RESULTS

All seven cases of T-PCNSL showed supratentorial and either superficial or subcortical location. Five patients had solitary mass and the others had multiple masses (two and three masses in each case). All tumors showed low T1 and slightly high T2 signal intensity to adjacent gray matter. Irregular ring enhancement was seen in 7 of 10 masses and nodular enhancement was seen in the others. Cortical hemorrhage was noted in three patients and intratumoral hemorrhage was noted in one. The two masses on rCBV map demonstrated either similar to or slightly higher signal intensity than that of contralateral white matter. The rCBV ratio of each mass was 1.27 and 1.35.

CONCLUSION

Predilection for subcortical location, relatively high incidence of cortical hemorrhage, and lower rCBV may be helpful for differentiating T-PCNSL from other brain tumors.

KEY WORDS: Lymphoma, T-cell

Poster 51**Susceptibility-Weighted Imaging of Brain Masses**

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PURPOSE

Tumor characterization involves understanding the angiographic behavior of lesions, including angiogenesis and internal hemorrhage. Susceptibility-weighted imaging (SWI) has been found to be particularly well suited for visualization of venous structures, venous malformations, and microhemorrhage within the brain (1-2). In this study, we investigate the role of SWI in determining tumor structure and vascular boundaries.

MATERIALS & METHODS

Susceptibility-weighted imaging is a high-resolution, three-dimensional, fully velocity-compensated gradient-echo sequence. Postprocessing is applied using both magnitude and phase images to increase the conspicuity of the veins and other sources of susceptibility effects. This sequence has been applied to 44 patients (24 males, 20 females, aged 15 to 89 years, mean 50.3 years) with brain masses, pre and/or post contrast and compared to conventional sequences (T1, T1 post contrast, T2, proton density, FLAIR and diffusion-weighted imaging). Seventeen cases had pathologic correlation.

RESULTS

In the majority of the cases SWI gave better contrast and/or structural information than T1-weighted postcontrast images. In a minority of cases, the reverse was true. This demonstrates the complementary nature of the two approaches and the importance of collecting SWI data. On the whole, SWI was more sensitive for showing blood products and venous vasculature. Susceptibility-weighted imaging showed a useful FLAIR-like contrast and added complementary information to conventional T1 postcontrast sequences for internal architecture study of the lesions. Good pathologic correlations were found for blood products as predicted by SWI.

CONCLUSION

Susceptibility-weighted imaging should prove useful for tumor characterization because of its ability to better highlight blood products and venous vasculature.

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KEY WORDS: Neoplasm, susceptibility-weighted imaging, hemorrhage

Poster 52**A Detailed, Comprehensive, and Quickly Performed Functional MR Imaging Approach to Brainstem Tumors**

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PURPOSE

To determine whether functional MR imaging sequences (diffusion, diffusion tensor, tractography, perfusion, spectroscopy) can help add new information to approach brain stem tumors.

MATERIALS & METHODS

During the period of 6 months, MR exams of 4 patients (2 men and 2 woman, mean age 35 years) were performed in a 1.5 T clinical scanner (Siemens, Germany), using MR clinical standard protocol and functional sequences (diffusion, diffusion tensor imaging, tractography, perfusion, and spectroscopy). All the patients had their histopathology diagnosis confirmed by brain biopsy: gliomatosis cerebri (n = 1); low grade glioma type I (n = 2) and low grade glioma type II (n = 1). All of them had low relative cerebral blood volume.

RESULTS

Proton MR spectroscopy imaging pattern was characterized by the presence of high levels of myo-inositol/glycine, no significant elevation of choline, and mildly reduced N-acetylaspartate. Color maps of diffusion tensor imaging and tractography of the brain stem white matter tracts were preserved in the cases of gliomatosis cerebri and low grade glioma type I (n = 2).

CONCLUSION

Diffusion tensor imaging and tractography may provide useful adjunctive information about the infiltrating compartment of the tumors which is not available in other MR techniques. Because this study was based on a small sample of patients, we should consider the results preliminary and exercise caution before using them in clinical practice.

KEY WORDS: Brainstem neoplasm, diffusion tensor, tractography

Poster 53**Intracranial Epidermoid Cysts: Diffusion-Weighted, Fluid-Attenuated Inversion Recovery, and Conventional MR Findings**

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PURPOSE

To assess the utility of diffusion-weighted echo-planar imaging (DW EPI) sequence in the evaluation of epidermoid cysts (ECs) compared to conventional spin-echo (SE) and fluid-attenuated inversion recovery (FLAIR) sequence MR imaging, and to evaluate the role of T2 shine-through effect.

MATERIALS & METHODS

Fifteen patients (10 primary, 5 residual ECs) were imaged prospectively in two different 1.5 T MR units with standard head coils with T1-weighted SE, and T2-weighted fast SE, FLAIR and DW EPI sequences. The qualitative and quantitative assessments were performed by two radiologists in consensus. Apparent diffusion coefficient (ADC) values were obtained from all ECs. For 11 ECs, exponential DW images are obtained to eliminate T2 shine-through effects. The results are analyzed with variance analysis (ANOVA) and Bonferroni t method.

RESULTS

All ECs were moderately heterogeneous and isointense compared to CSF on T1-weighted SE, and were isointense with CSF on T2-weighted fast SE. FLAIR sequence was superior to T1- and T2-weighted sequences in showing ECs. In 13 cases, the borders of the lesions could not be delineated from the surrounding structures with either FLAIR or T1/T2-weighted sequences. All ECs were markedly hyperintense on DW imaging compared to CSF and deep white matter. The ADC values of the lesions ranged from 0.986 to 1.360 (mean $1.157 \pm 0.12 (\pm SS) \times 10^{-3} \text{ mm}^2/\text{s}$), CSF ranged from 3.214 to 3.762 ($3.423 \pm 0.16 \times 10^{-3} \text{ mm}^2/\text{s}$) and deep white matter ranged from 0.879 to 1.40 ($0.993 \pm 0.08 \times 10^{-3} \text{ mm}^2/\text{s}$). The ADC values of ECs are significantly lower than CSF ($p < 0.001$), and significantly higher than deep white matter ($p < 0.01$). On exponential DW images, ECs had similar intensity with brain parenchyma showing that the real cause of the hyperintensity of the lesions on trace images is the enhanced T2 effect of the tissue.

CONCLUSION

FLAIR sequence is superior to the conventional MR sequences in demonstrating the ECs and DW imaging is superior to other MR sequences in delineating the borders of the ECs from the brain parenchyma and the surrounding CSF spaces. Exponential DW images had shown that the hyperintensity in the trace images are caused by increased T2 effect of the lesion rather than the decrease in ADC values. DW EPI sequences should be added to the conventional MR sequences in the evaluation of ECs.

KEY WORDS: Epidermoid, MR imaging, diffusion imaging

Poster 54**Usefulness of Gadobenate Dimeglumine (Multihance) for Intraoperative MR Monitoring of Brain Tumor Surgery**

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PURPOSE

To illustrate the usefulness of Multihance (gadobenate dimeglumine) for intraoperative MR monitoring of brain tumor surgery.

MATERIALS & METHODS

Between October and November 2003, 59 patients underwent tumor resection monitored by repeated MR scanning performed in the operating theater. An intraoperative MR system "Polestar N10" (Medtronic Odin) with a permanent magnet operating at a low magnetic field of 0.12 T was used. A first MR acquisition was obtained at the beginning of the surgery followed by one or two further acquisitions during or/and at the end of the procedure. The following tumors were included: 27 intrasellar tumors operated by transsphenoidal route, 11 tumors in the frontal/parietal cortical region, 7 tumors of the supra and parasellar region extending to the third ventricle, 6 temporal lesions, 5 posterior fossa tumors and three parieto-occipital paraventricular lesions. Pathologic examination confirmed 26 pituitary adenomas, 5 craniopharyngiomas, 3 meningiomas, 13 glial tumors, 2 metastases, 1 cavernoma, 1 vestibular schwannoma, and 1 teratoma. A further 6 lesions comprising 3 mesiotemporal scleroses, 1 DNT, 1 cortical dysplasia and 1 low-grade temporal glioma were removed for treatment of epilepsy. All patients had a complete preoperative MR work-up for surgical planning. Gadobenate dimeglumine at a dose of 0.1 mmol/kg was used. Further intraoperative injections of 0.1 mmol/kg gadobenate dimeglumine were performed in 38 patients to enhance and better delineate the tumors.

RESULTS

Intraoperative tumor detection and visibility was improved in each of the 38 patients who received gadobenate dimeglumine during surgical intervention. The increased T1 relaxivity of gadobenate dimeglumine compared to conventional gadolinium chelates permitted lower overall doses to be used and proved advantageous at the low magnetic field in use in the operating theatre. The use of multiple injections was not problematic and no adverse reactions were noted by the anesthesiologists.

CONCLUSION

Multiple contrast injections are required to monitor the progressive removal of brain tumors by intraoperative MR imaging. The high relaxivity characteristics of gadobenate dimeglumine allow excellent visualization of the enhancing tumors at lower doses compared to conventional gadolinium contrast agents.

KEY WORDS: Intraoperative MR imaging, brain tumors, Multihance

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of Multihance (gadobenate dimeglumine) made by Bracco (Italy) for intraoperative MR monitoring of brain tumor surgery.

Poster 55**Correlation of Dynamic Contrast MR Imaging to Angiographic Imaging Findings in Extraaxial Tumors**

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PURPOSE

To determine whether perfusion patterns of extraaxial tumors receiving most arterial supply from the external carotid circulation significantly differ from those predominantly receiving arterial supply from the internal carotid artery.

MATERIALS & METHODS

Arteriograms and dynamic contrast MR images were reviewed in 13 patients who presented with extraaxial tumors. These patients all underwent echo planar T2 dynamic contrast-enhanced 1.5 T MR imaging using spin-echo multiphase EPI using (11 interleaved slices with TE = 80, a TR = 1900, FOV = 30, NEX=1). Adequate intravenous access was obtained using a 21-gauge needle and contrast was injected at 5 cc/sec using a mechanical injector for a total volume of 0.2 mmol/kg and a maximal dose of 20 ml contrast. These patients also underwent cerebral arteriography intended for preoperative embolization. Arteriograms were inspected for source of blood supply and a percentage supply from the extracranial vasculature was estimated. Signal intensity vs time curves were compared to gray matter and the relative delay in transit time relative to gray matter was calculated. Relative cerebral blood volumes were calculated using the limited integration method and the tumors were categorized as high medium or low relative to gray matter.

RESULTS

No pattern could be identified which could help distinguish external carotid supply from internal carotid supply to the tumor. All neoplasms displayed similar curves regardless of arterial source. Neither relative cerebral blood volumes nor tumoral contrast transit time on MR imaging demonstrated any statistically significant correlation to the degree of external carotid supply.

CONCLUSION

Source of vascular supply (internal carotid vs external carotid) does not appear to have a substantial influence on the pattern of tumoral perfusion in extraaxial tumors. The pattern of perfusion is thought to be related to the intrinsic nature of the neoplasm.

KEY WORDS: Dynamic contrast MR imaging, meningioma, angiography

Poster 56

Tissue Signatures Characterization of Diffusion Tensor Abnormalities in Cerebral Gliomas

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PURPOSE

The appalling prognosis of cerebral gliomas relate to their propensity to diffusely infiltrate white matter tracts. Tumor cells extend beyond the limit of the tumor seen on conventional MR imaging. Better methods of identifying tumor margins may allow us to individualize radiotherapy plans. Diffusion tensor imaging (DTI) is a technique that is sensitive to the ordered diffusion of water molecules along white matter tracts. It can detect abnormalities beyond the limits seen on T2-weighted images. The diffusion tensor is represented commonly by the fractional anisotropy index (FA), but this can be insensitive to subtle pathologic changes. We have developed a novel methodology that decomposes the diffusion tensor into the isotropic (p) and anisotropic (q) components. By plotting these graphically as the x and y axis we can derive a diffusion tissue signature. We report our experience of this technique in both normal brain and cerebral gliomas.

MATERIALS & METHODS

Thirty-five patients with cerebral gliomas and 7 normal volunteers were recruited for this study. All patients were imaged at 3 T using a T2-weighted sequence and a single-shot spin-echo EPI DTI sequence (TR = 5070 ms, TE = 107 ms, matrix 128 x 128, FOV 25 x 25 cm, slice thickness 5 mm, 8-27 slices, using 12 noncolinear gradients and 5 b-values from 318 - 1570 s/m). Maps of FA, p and q were produced for each patient. The principal axes of diffusion also were determined and RGB color-coded orientation maps created. Regions of interest (ROI) then were selected as showing white matter disruption, infiltration, or displacement according to the method described by Witwer. For each ROI p and q values were derived and plotted as tissue signatures. In addition, the direction of the principal axis of diffusion from a 3 x 3 ROI was displayed on a rose diagram. For each, the magnitude of the largest vector and the spread of the vectors were determined.

RESULTS

The diffusion tissue signatures for the normal volunteers showed that there was limited spread of the p values. The anisotropic q values varied with different white matter types; commissural fibers in the corpus callosum had larger values compared to association fibers like the occipital radiation (q

values of 1.05 vs 0.5, respectively). In the tumor patients, tissue signatures of displaced white matter tracts were no different from contralateral values. In infiltrated tracts there was a marked increase in p values with minimal change in q. In disrupted tracts there was an increase in p with a corresponding decrease in q. The magnitude of the largest vector from the principal axis of diffusion inversely correlated to the p value (Pearson coefficient -0.765, $P < 0.001$). The angle of dispersion of the principal axes of diffusion inversely correlated with the q value.

CONCLUSION

Diffusion tensor tissue signatures are a useful method of simultaneously visualizing the anisotropic and isotropic components of diffusion and can detect subtle changes in white matter in tumor infiltration. Further studies are required to identify the pathologic changes that the p and q values may identify.

KEY WORDS: Diffusion tensor imaging, gliomas

Poster 57

Brain Tumor Characterization by MR Spectroscopic and Perfusion Imaging

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PURPOSE

The purpose of our study is to combine MR spectroscopic (MRS) and perfusion imaging to differentiate infiltrative tumor from vasogenic edema in patients with primary malignant brain tumors.

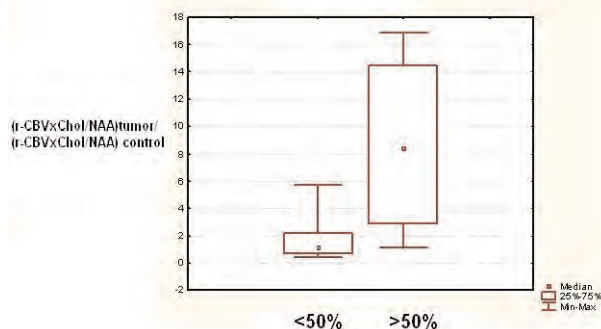
MATERIALS & METHODS

Five patients with primary brain tumors (2 females, 3 males, mean age = 45.5 years, 1 anaplastic astrocytoma, 3 glioblastoma multiforme, and 1 oligodendroglioma) underwent MRS (1) and perfusion imaging (2) before surgical resection. Three or four biopsies were obtained intraoperatively in each patient, from the tumor and peritumoral region, immediately before resection with registration of the coordinates of each biopsy site. The peritumoral region was defined as the white matter immediately adjacent to the enhancing margin of the tumor, with high signal on T2 and FLAIR images and no enhancement on postcontrast T1-weighted images. A total of 10 biopsies were available for interpretation. The biopsies were analyzed by a neuropathologist blinded to the clinical information and were classified into four categories (1: no tumor cells, 2: < 50% tumor cells, 3: 50-99% tumor cells and 4: 100% tumor). We calculated the corresponding normalized values for the relative cerebral blood volume (rCBV), choline (Cho), creatine (Cr), N-acetyl aspartate (NAA), as well as the normalized Cho/NAA, and NAA/Cr ratios corresponding to the biopsy locations. The control areas were chosen in the corresponding locations in the contralateral hemisphere. We used the Mann-Whitney U test to assess for significance in correlation with the histopatholog-

ic classification. We also calculated $(r\text{-CBV}_{\text{Tumor}} \times \text{Cho}/\text{NAA}_{\text{Tumor}})/(r\text{-CBV}_{\text{control}} \times \text{Cho}/\text{NAA}_{\text{control}})$ for all the biopsies.

RESULTS

A trend emerged of increased $r\text{-CBV}$ ($P = 0.055$), decreased NAA ($P = 0.63$), NAA/Cr ratio ($P = 0.66$) as well as increased Chol (0.52) and Chol/NAA ratio ($P = 0.28$) in biopsies with $>50\%$ tumor cells when compared to biopsies with $<50\%$ tumor infiltration.



CONCLUSION

In this pilot study, combined MRS and perfusion imaging may enable differentiation of areas with tumor infiltration from those with vasogenic edema in patients with primary brain tumors.

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KEY WORDS: Glioma, MR spectroscopy, MR perfusion

Poster 58

Enhancing Lesions of the Brain: Intraindividual Quantitative and Qualitative Comparison of Contrast Enhancement after Gadobenate Dimeglumine vs Established Gadolinium Comparators

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PURPOSE

Gadobenate dimeglumine (Gd-BOPTA, MultiHance®, Bracco Imaging SpA, Milan, Italy) is a paramagnetic contrast agent whose T1 relaxivity in vivo ($r_1 = 9.7 \text{ mmol} \cdot \text{L}^{-1} \cdot \text{s}^{-1}$) is approximately twice that of Gd-DTPA, Gd-DOTA, and

other available gadolinium agents due to a unique capacity for weak and transient interaction with serum albumin. This feature may contribute to the improved detection, delineation, and conspicuity of enhancing intracranial lesions for which blood-brain barrier breakdown results in elevated levels of serum proteins. Presented are the results of a fully blinded, independent off-site evaluation of the quantitative and qualitative enhancement obtained after a dose of 0.1 mmol/kg Gd-BOPTA, compared with that obtained after an equivalent dose of either Gd-DTPA or Gd-DOTA.

MATERIALS & METHODS

Forty-five patients (31M/14F) with suspected glioma or cerebral metastasis underwent two successive randomized, double-blinded MR exams with Gd-BOPTA and either Gd-DTPA ($n = 23$) or Gd-DOTA ($n = 22$) at equal dose (0.1 mmol/kg). The imaging parameters and equipment were identical for the two examinations for each patient. The contrast agents were administered by power injector at 2 ml/s with the second agent administered between 24 hours and 14 days after the first agent. Images were acquired predose (T1-weighted SE, T2-weighted FSE sequences) and postdose (sequential T1-weighted SE sequences at 2,4,6,8,10,15 min with a T1-weighted SE-MT sequence at 12 min) at either 1 T (Philips; 16 patients) or 1.5 T (Siemens; 29 patients) using a head coil. Quantitative [lesion-to-brain ratio (L/B), contrast-to-noise ratio (C/N), and % lesion enhancement (%En)] and qualitative assessment of lesion enhancement was performed by two independent fully-blinded off-site readers. Statistical significance for quantitative evaluations was determined using paired t-tests while significance for qualitative evaluations was determined using the Wilcoxon signed rank test.

RESULTS

Images from 43/45 patients were available for quantitative assessment. After correction for precontrast values, significantly greater L/B ($p < 0.003$), C/N ($p < 0.03$) and %En ($p < 0.0001$) was noted by both readers for Gd-BOPTA-enhanced images at all time-points from 2 min postcontrast. Qualitative matched-pairs assessment of all 45 patients revealed significant preference for Gd-BOPTA over combined comparator for lesion border delineation ($p < 0.004$, both readers), lesion internal morphology ($p < 0.008$, both readers), global contrast enhancement ($p < 0.0001$, both readers) and global diagnostic preference ($p < 0.0005$, both readers). Although not designed to evaluate lesion detection, more lesions were detected on postdose images after Gd-BOPTA than after comparator agent (reader 1: 75 vs. 72; reader 2: 77 vs. 72). Similarly, interreader agreement was significantly greater after Gd-BOPTA (weighted kappa for contrast enhancement = 0.244; 95% C.I. 0.065, 0.422 after Gd-BOPTA vs. 0.094, 95% C.I. -0.078, 0.267 after comparator).

CONCLUSION

This fully blinded intraindividual comparison confirms that Gd-BOPTA has preferential contrast enhancing characteristics compared to conventional gadolinium agents. The superior contrast enhancement achieved with Gd-BOPTA may impact positively on overall patient management as well as presurgical planning and postsurgical follow-up. Furthermore, the significantly greater enhancement at early postcontrast time points may be clinically highly advantageous in permitting a greater daily throughput of patients.

KEY WORDS: Contrast agents, comparative studies, brain tumors

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of MultiHance (gadobenate dimeglumine) made by Bracco SpA for CNS imaging.

The authors of this work have indicated the following affiliations/disclosures: 1. Bracco-Altanapharma: Employee; 2. Bracco Diagnostics Inc.: Employee; 3. Bracco Imaging SpA: Employee.

Poster 59

3 T High Resolution MR Imaging and MR Spectroscopy for Surveillance of Brain Tumors

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PURPOSE

To employ MR spectroscopy (MRS) as a tool for tumor surveillance.

MATERIALS & METHODS

Nineteen patients with primary (no. = 14) and metastatic (no. = 5) brain tumors were followed with 3 T MRS and MR imaging. Patients with metastases had received radiation therapy and were studied to determine if enhancing masses represented recurrent metastases or radiation necrosis. Some primary brain tumor patients were referred for diagnostic evaluation and all were studied after treatment. Nine patients had two examinations, six had three exams, one had seven exams, and two had ten exams by the time of this report. 3 T examination included 3 mm dual-echo T2-weighted, FLAIR, and GRE 3D T1-weighted pre and postinjection of 20 ml gadopentetate dimeglumine. MR spectroscopy was performed with a PRESS sequence (TR = 2000/TE = 35 msec, FOV = 24 cm), 1cm slice thickness and 16 x 16 phase encoding steps. Evaluation was based on the relative amounts of choline (Cho), creatine (Cr), N-acetylaspartate (NAA), lipid/lactate, and myoinositol in the spectra and on measurements of Cho/Cr ratios. Spectral samples were obtained in and around tumors and tumor resection/treatment sites, and matched to T2-weighted and gadolinium-enhanced T1-weighted scans.

RESULTS

Surveillance examinations of primary brain tumor patients ranged from improving or stable spectral abnormalities in patients responding to treatment (surgery and radiation therapy; 6 patients), to increasing abnormalities with tumor progression (5 patients). In tumors that progressed, there were variable imaging signs of progression (i.e., increased area of T2 signal abnormality and increased enhancement), which, overall, were not as extensive as the spectral abnormalities. In one case there is stable anatomical appearance of the tumor treatment site over 15 months and 10 examinations, but there is a trend toward increasing choline and decreasing NAA around the tumor resection site, which is a change that may represent late radiation effects or be an early sign of recurrence. In one patient with a brainstem glioma, treatment reduced the bulk and signal abnormality of the mass, but the moderate spectral abnormalities observed at the time of diagnosis persisted. Surveillance examinations of the patients with metastases demonstrated progressive MRS abnormalities suspicious for tumor recurrence, accompanied by enlargement of masses, in two patients. In both cases this information lead to surgery and recurrence was proven. In two patients with metastases, spectra were mildly deviant from normal and suspected to be related to radiation effects. These patients have been clinically stable. One patient had an enlarging enhancing mass without increased choline, but with an elevated lipid/lactate peak. This was suspicious for radiation necrosis, which was proven at surgery.

CONCLUSION

As a tool for tumor surveillance, MR spectroscopy expands our analytic and diagnostic capability for determining the metabolic activity of tumors. We have shown that MRS contributes additional diagnostic information in the ongoing evaluation of brain tumors that can influence treatment decisions. Further study should demonstrate if the metabolic abnormalities detectable with MRS are reliably an earlier sign of tumor recurrence than standard features, and thus, may lead to earlier intervention and improved outcomes for these patients.

KEY WORDS: Spectroscopy, brain tumor, three tesla

Poster 60

Cavernous Malformation: Diffusion-Weighted Imaging Findings

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PURPOSE

The purpose of this study was to evaluate the detectability of cavernous malformation by means of susceptibility influence with different imaging sequences such as diffusion-weighted imaging (DWI), spin-echo (SE) echo-planar imaging (EPI) (b₀ images), fast SE-T2-weighted imaging (T2WI) and gradient-echo (GRE) sequences.

MATERIALS & METHODS

We reviewed a series of 34 patients (13 men and 21 women; 4-93 years of age, mean 43 years) with cavernous malformations who underwent MR imaging including DWI between October 2001 and September 2003. Additionally, GRE was obtained in eleven patients and GRE EPI in another twelve. For each lesion, the maximum size of signal loss was statistically evaluated using the Student's paired t-test. Surgical pathologies were obtained in eleven patients that confirmed cavernous malformations. Two patients had a familial history of multiple cavernous malformations. Other 23 patients were diagnosed on MR imaging findings. The symptoms of these patients were seizure (n = 12), headache (n = 7), focal weakness (n = 5), nausea (n = 2), loss of consciousness (n = 2), dizziness (n = 2), focal sensory loss (n = 1), mental status change (n = 1), aphasia (n = 1). Three patients had no neurologic symptoms.

RESULTS

All patients were examined with T2-weighted imaging and DWI. Forty-seven lesions were seen on both DWI and b_0 images. Forty-six of these lesions were also detected on T2-weighted imaging. The mean size of signal loss was 14 (range: 1-83) mm^2 on T2-weighted imaging, 18 (1-110) mm^2 on DWI and 20 (2-109) mm^2 on b_0 images. The difference with regard to size of signal loss was statistically different when comparing T2-weighted imaging vs DWI ($P < .01$), T2-weighted imaging vs b_0 images ($P < .01$), and DWI vs b_0 images ($P < .01$). In eleven patients, GRE was obtained also showing 22 lesions, whereas only 16 lesions of these were large enough to be detected on T2-weighted imaging, and 17 on DWI and b_0 images. The mean diameter of these 16 lesions was 22 (2-83) mm^2 on T2-weighted imaging, 29 (1-110) mm^2 on DWI, 31 (3-109) mm^2 on b_0 images and 32 (3-109) mm^2 on GRE. There was a statistical difference in size between T2-weighted imaging vs GRE ($P < .05$), but not between DWI, b_0 images and GRE. In another twelve patients, GRE EPI also was obtained showing 18 lesions, which were also detected on T2-weighted imaging, DWI and b_0 images. The mean size of these lesions was 11 (1-36) mm^2 on T2-weighted imaging, 14 (1-47) mm^2 on DWI, 17 (2-55) mm^2 on b_0 images and 26 (2-81) mm^2 on GRE EPI. Comparing these sequences, the difference between GRE EPI vs T2-weighted imaging, DWI and b_0 images were statistically significant ($P < .01$).

CONCLUSION

The susceptibility effect seen as increase in size of signal loss was the greatest on GRE sequences. The higher sensitivity for these sequences made it possible to detect more and smaller lesions. Diffusion-weighted imaging and b_0 images also can detect cavernous malformations but are not as sensitive.

KEY WORDS: Diffusion, cavernous malformation, MR imaging

Poster 61

Evaluation of Tumor Blood Flow Using an Arterial Spin Labeling Technique

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PURPOSE

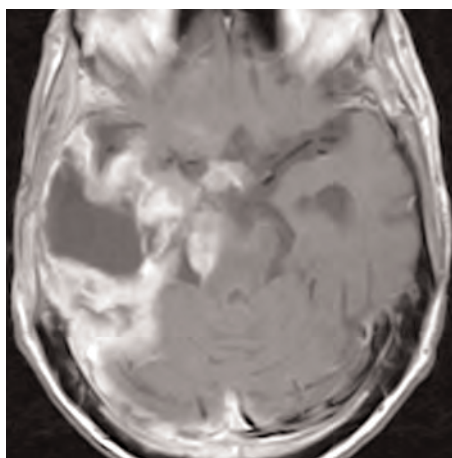
Information about vascularity is important for evaluating brain tumors. Purpose of this study was to estimate the usefulness of arterial spin labeling (ASL) techniques for evaluating the blood flow of brain tumors.

MATERIALS & METHODS

Forty-three patients with intracranial mass lesions (14 meningiomas, 14 gliomas, 7 metastatic tumors, 3 malignant lymphomas, 2 other tumors, and 3 brain abscesses) were studied with MR perfusion imaging using an ASL technique. All studies were performed with a clinical 1.5 T scanner (VISART/Ex, Toshiba, Tokyo) using a quadrature head coil. A single slice 2D or multislice 3D ASTAR (signal targeting with alternating radio frequency using asymmetric inversion slabs) technique was used with a TI of 1200, 1400, or 1600 ms. Relative tumor blood flow (rTBF) was calculated as follows: $\text{rTBF} = [\text{signal intensity (SI) of a tumor}] / [\text{SI of brain tissue in the territory of contra-lateral middle cerebral artery}]$. Angiography was performed in 14 patients with an extraaxial tumor. In these patients, correlation between angiographic findings and rTBF or pattern of ASL signal was evaluated.

RESULTS

All meningiomas but one showed rTBF higher than 1.0. Including atypical meningiomas, no significant difference of rTBF was observed between different histologic types. Nine of 12 high grade gliomas displayed rTBF greater than 1.0. Though only three metastatic tumors displayed high rTBF, metastatic tumors and gliomas could not be discriminated by rTBF. Relative tumor blood flow of malignant lymphomas, low grade gliomas (pilocytic astrocytomas), and abscesses was lower than 1.0. Findings of angiography and rTBF of extraaxial tumors were not well correlated. In tumors with large tumor vessels, inhomogeneous hypervascular area was observed. This suggested the influence of residual intravascular labeled spins on the signal of ASL. In some patients, TBF images were useful to diagnose recurrent tumor or radiation necrosis (Figure).



CONCLUSION

Arterial spin labeling techniques could be used to estimate tumor vascularity. However, several problems such as the influence of arterial transit time remain to be resolved.

KEY WORDS: Arterial spin labeling, perfusion, tumor blood flow

Poster 62

Perfusion MR Imaging of Brain Tumors with Gd-BOPTA (MultiHance)

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PURPOSE

Perfusion measurements of the brain by contrast-enhanced MR imaging is becoming more and more popular. The method already has proven effective for the assessment of cerebrovascular diseases, for brain tumors, and for monitoring after radiotherapy. A crucial aspect for the quality of the perfusion measurements and the reliability of the results is the amount of the relative signal reduction, which is dependent on the concentration and the relaxivity of the contrast agent used. The present study was conducted to evaluate two of the newer generation contrast agents for cerebral perfusion MR imaging. Specifically, the weakly protein interacting MR contrast agent MultiHance® was compared with the one-molar agent Gadovist® at single (0.1 mmol/kg) and double (0.2 mmol/kg) dose in both healthy volunteers and patients.

MATERIALS & METHODS

A randomized intraindividual comparative study was conducted in 12 healthy male volunteers and 30 patients with cerebral gliomas. The imaging parameters, slice positioning, and contrast media application were standardized. For the quantitative assessment the rCBV and rCBF of gray and white matter, the percentage signal drop and the full width half maximum (FWHM) of ROI signal time curves were calculated. For a qualitative analysis the image quality of the

rCBV and rCBF maps in respect of delineation of clinical utility, gray and white matter and basal ganglia delineation were evaluated in an independent off-site assessment.

RESULTS

On-site evaluation of the study in healthy volunteers revealed that single doses of the new contrast agents were sufficient to achieve high quality perfusion maps. No differences in susceptibility effect, described by the percentage of signal loss, were apparent between the two contrast agents (Table 1). The FWHM was equal for the single dose of both agents and the double dose of Gadovist®. Only the double dose of MultiHance® led to a significant widening of the signal time curve ($p < 0.05$). The calculated rCBV and rCBF values of the different ROIs were constant for both dosages and contrast media. At the qualitative off-site assessment both readers found the double dose images to be better suited for gray-white matter differentiation and the delineation of the basal ganglia. However, there was no difference between the contrast agents and single dosage offered good image quality for rCBF in all but one of the exams (Table 2). In the patient study performed with single dose of contrast media all perfusion scans were of excellent diagnostic quality without a difference between the used contrast media. An absolute quantification of perfusion data was possible with the use of these new agents.

CONCLUSION

The susceptibility effect of the new generation contrast agents is stronger than for conventional MR contrast media. The one molar MR contrast agent Gadovist® has no advantages over MultiHance®, an MR contrast agent with a higher relaxivity in perfusion MR imaging. Both agents allow the calculation of high quality perfusion maps at a lower contrast agent dosage.

KEY WORDS: Brain tumors, perfusion, absolute quantification

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of: 1. MultiHance made by Bracco Diagnostics for cerebral perfusion MR imaging; 2. Gadovist made by Schering/Berlex for cerebral perfusion MR imaging.

The authors of this work have indicated the following affiliations/disclosures: 1. Bracco Diagnostics: Employee; 2. Bracco-Altanapharma: Employee.

Poster 63

Unusual Presentation of Calcified, Isolated Brain Metastases in Patients with Previous History of Breast Carcinoma Treated with Surgery and Chemotherapy: Report of Four Cases

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PURPOSE

Cerebral metastases (CM) represent the most frequent brain tumors. Although of typical appearance in most cases, sometimes an unusual presentation may behave to uncorrect diagnosis, the most frequent diagnostic dilemma being between CM and meningiomas. We observed four cases of CM in patients previously treated for breast cancer with surgery and chemotherapy, initially misdiagnosed.

MATERIALS & METHODS

Four female patients, previously treated for breast carcinoma with surgery and chemotherapy (age range....), were studied in our institutions in the period 1997-2003. All of them received chemotherapy with standardized protocols: three underwent also local radiotherapy. G.A. (age 62 years), 28 months after surgery with lymph node ablation, chemo and radiotherapy, developed a large right posterior temporoparietal cystic and calcific lesion with surrounding edema. B.C. (age 56 years), 34 months after surgery and CMF protocol presented a left cerebellar partially calcified and irregularly enhancing mass. P.S. (age 58 years), 32 months after mastectomy and radio-chemotherapy showed neurologic cerebellar deficit: CT and MR imaging demonstrated a calcific lesion in the posterior fossa with dural and parenchymal involvement. C.A. (age 63 years), presented cerebellar symptomatology 40 months after left breast quadrantectomy integrated with chemo-radiotherapy. The following CT and MR examinations showed a calcified left emispherical lesion involving omolateral transverse sinus and tentorium. All patients underwent pre and postcontrast CT scan, followed by 1 and 1.5 T pre and postgadolinium MR examination.

RESULTS

All lesions had similar characteristics at the onset of neurologic symptoms: large, single, calcified, cystic mass with inhomogeneous enhancement and slight surrounding edema. Surgery, with complete removal of the lesions, was performed in all cases. Histology documented secondary lesions compatible with breast cancer cells. One month after surgery all patients received whole brain radiotherapy.

CONCLUSION

As reported in the literature atypical presentation of brain metastases can create diagnostic difficulties. In our series all the patients, with known previous breast cancer, developed large, calcified lesions with or without cystic component. We suggest that chemotherapy may play a role in the development of such atypical lesions.

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KEY WORDS: Cerebral metastases, calcifications, chemotherapy

Poster 64

Correlation between Fiber-Tracking Images of Optic Tracts and Visual Field Defects in the Cases after Temporal Lobectomy

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PURPOSE

Patients after anterior temporal lobectomy for temporal epilepsy shows various degrees of visual field defects because of optic tract injury. Purpose of this study is to evaluate correlation between distribution and severity of visual field defect and continuity of fiber-tracking images that represent optic radiation on diffusion tensor tractography for postlobectomy patients.

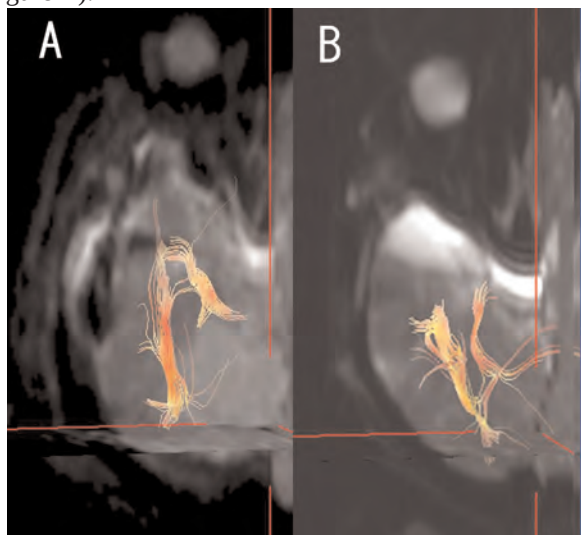
MATERIALS & METHODS

We examined 8 cases after temporal lobectomy for temporal lobe epilepsy. Degree of visual field defect was classified into three groups upon the deficits in upper quadrant visual field: Group A: moderate deficit in the medial sector and intact lateral sector field; Group B: complete deficit in the medial sector and moderate deficit in the lateral sector field; Group C: complete deficit in both medial and lateral sector field. Diffusion tensor images (EPI sequence; TR = 180, TE = 96, b = 1000, 6 axis encoding) were acquired using Magnetom Sonata (1.5 T, Siemens AG, Germany). Fiber-tracking images that are considered to represent optic radiation was made using diffusion tensor imaging software (dTV ver1.5) developed by Masutani (Department of Radiology, The University of Tokyo). Fiber-tracking images for global side of optic tract was drawn by placing seeds at fibers ante-

rior to lateral geniculate body. Seeds were placed at lateral sagittal layer of temporal lobe to draw fiber-tracking images for cortical side of optic tract. We evaluated continuity of those fiber-tracking images for three patient groups and correlated with distribution and severity of visual field defect.

RESULTS

There was a tendency that visual deficit spread from medial sector to lateral sector according to severity. Group A, which is the least severe group, consisted of 2 cases, continuity of fiber-tracking images for optic tract was well depicted on MR tractography in all 2 cases (Figure A). Group B consisted of 3 cases. Two of them showed incomplete continuity of fiber-tracking images for optic tract and one showed complete discontinuity of fiber-tracking images for optic tract at the region of Meyer's loop. Group C was the most severe group and consisted of three cases. All of them showed complete discontinuity of fiber-tracking images for optic tract (Figure B).



CONCLUSION

Medial sector of upper quadrant field tends to be more impaired than lateral sector after temporal lobectomy. This phenomenon seems to reflect anatomical construction that the fibers for medial sector are located in anterior part of Meyer's loop. Continuity of fiber-tracking images for optic tract on diffusion tensor tractography correlated to the degree of visual field defect after anterior temporal lobectomy. MR tractography of temporal lobe was useful in monitoring optic tract after temporal lobectomy. This result was obtained by using the free software dTV (<http://www.ut-radiology.umin.jp/people/masutani/dTV.htm>) for MR-DTI analysis developed by Image Computing and Analysis Laboratory, Department of Radiology, The University of Tokyo Hospital, Japan.

KEY WORDS: Tractography, optic tract, temporal lobectomy

Poster 65

Neuron Cell Body Initialization: A New Algorithm for the Physiologic Initialization of 3D Curves in Fiber Tractography

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PURPOSE

Many algorithms have been developed for the creation of three-dimensional (3D) curves, the mathematical equivalent of white matter fibers, from MR diffusion tensor images (MR DTI). The purpose of this research is to develop a new method of 3D curve initialization to replace the common practice of initializing curves everywhere within the white matter, a method we will refer to as uniform spatial initialization (USI). This new method, neuron cell body initialization (NCBI), simulates brain physiology by initializing 3D curves near the gray/white interface where axons normally would enter the white matter.

MATERIALS & METHODS

Spin-echo echo-planar diffusion tensor images are acquired on eight normal volunteers in the axial plane using a GE 1.5T LX MR scanner. A linear multiple regression algorithm statistically estimates the diffusivity constants of the resultant super-tensor (13 axis) data sets, followed by diagonalization and calculation of Eigenvalues and Eigenvectors. Sixty 128 x 128 images are acquired with a slice thickness of 4.0 mm with a 2.0 mm offset. These images are super-sampled and 60 additional images are linearly interpolated for a total three-dimensional (3D) matrix size of 256 x 256 x 120 with a voxel aspect ratio of 0.9375 x 0.9375 x 1.0 mm. The fractional anisotropy (FA) at each voxel is calculated. An FA threshold of 0.3 was shown empirically to be a good estimate of the gray/white matter interface. Voxels within the white matter that border gray matter have an FA between 0.3 to 0.7 and are marked as possible candidates for 3D curve initialization. Next, the 3D image gradient is calculated from the FA data. This gradient produces a 3D vector at each of the marked voxels that points from the gray matter orthogonally into the white matter. This is the expected course of axons entering the white matter from the neuron cell bodies in the gray matter. The axons following this course should be aligned with principal Eigenvector of the MR DTI. A dot product therefore is formed between these two vectors. If the absolute value of this dot product is greater than 0.5 then a 3D curve is initiated from this voxel and travels in both directions until it terminates when trilinearly interpolated FA falls below 0.3. Termination therefore should occur at the gray/white interface. Results were output in VRML format for review.

RESULTS

Curves passing through the corpus callosum were segmented and shown to correlate better with known fiber pathways and tract densities described in the literature when NCBI was used compared to USI. Neuron cell body initialization was also more than twice as fast as USI in computing these pathways by reducing the number of curves calculated from over 545K to 203K.

CONCLUSION

This presentation describes the NCBI algorithm in detail. It is our hope that other researchers might find this simple but powerful method of value in their own research.

KEY WORDS: Fiber tractography, diffusion tensor imaging, postprocessing

Poster 66**Optimization of T1-Weighted Brain Imaging on 3 T MR System**

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PURPOSE

The availability of high field (3 T) MR scanners in clinical practice theoretically offers the benefit of increased signal-to-noise ratio (SNR) and therefore improved evaluation of the neurocranium. On T1-weighted images of the brain, however, the image contrast of this technique often may be poor in high field imaging. Since T1 relaxation times are longer at higher fields and the relative signal characteristics of many brain tissues are similar, it is more difficult to obtain T1-weighted images with sufficient contrast on high field systems, and the established protocols used in 1.5 T imaging cannot be simply extrapolated to 3 T imaging. Our goal was to optimize 3 T image quality by testing a variety of T1-weighted sequences in the clinical setting.

MATERIALS & METHODS

Twenty-five consecutive patients imaged on a 3 T scanner were divided into five groups. For each group of five patients a different T1-weighted sequence was utilized: spin-echo (SE), inversion recovery (IR), gradient-echo (GRE), fluid-attenuated inversion recovery (FLAIR), and turbo gradient-echo (TGE). Subjective evaluation of susceptibility and pulsation artifact degradation and overall image quality was performed by two independent observers, using a scale from one to three. Images then were analyzed via objective measurement of contrast between white matter and gray matter, white matter and cerebrospinal fluid, as well as the degree of increase in signal intensity with gadolinium.

RESULTS

Gradient-echo images demonstrated pronounced susceptibility artifact which degraded image quality and were excluded from further analysis. Subjective evaluation of FLAIR and TGE images was superior to the other T1 techniques. The average overall score was 2.7 for FLAIR, 2.3 for turbo gradient-echo, 2.1 for IR, and 2.1 for SE. There were no significant differences between the raters' scores. Inversion recovery images showed by far the best overall contrast, however enhancement with gadolinium was inconspicuous. Objective measurements of contrast however demonstrated better average contrast with spin-echo sequence than with FLAIR, but with a much larger standard deviation (Table 1), indicating that spin-echo T1-weighted images were far less consistent. The same was true for enhancement with gadolinium. The average increase in signal intensity/standard deviation

(AISI/SD) was 1167/382 with FLAIR and 1388/1184 with spin-echo sequence. Turbo gradient-echo images provided somewhat less prominent, but less variable contrast enhancement: 888/55 (AISI/SD).

Contrast on different sequences (average/standard deviation)

	Inversion Recovery T1w	FLAIR T1w	Turbo gradient- echo-T1w	Spin-echo T1w
White Matter/Gray Matter	1333/506	204/59	180/35	263/208
White Matter/CSF	5291/856	695/165	574/119	2696/696

CONCLUSION

Overall, T1-weighted FLAIR offered superior image contrast, acceptable image artifact, and comparable acquisition time. Interestingly, the literature shows that T1-weighted FLAIR also was found optimal for a low field (0.2 T) MR system. The T1-weighted FLAIR may be the sequence of choice for high field intracranial imaging in the clinical setting. Turbo gradient-echo sequence appears a good alternative when 3D acquisition is needed.

KEY WORDS: 3 T, pulse sequences, T1-weighted images

Poster 67**Pyramidal Tracts by Diffusion Tensor Tractography in Patients with Arteriovenous Malformations**

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PURPOSE

Diffusion tensor imaging and tractography can visualize the supratentorial pyramidal tract consistently and can provide detailed anatomical information about the relationship between the tracts and adjacent structures and diseases, such as tumors, hematomas, and infarction. We used diffusion tensor tractography to analyze and clarify the relationship between arteriovenous malformations (AVMs) and the pyramidal tract and also to clarify the changes of the tracts by the status of AVMs.

MATERIALS & METHODS

Twenty consecutive MR studies with diffusion tensor imaging of 12 patients with cerebral AVMs adjacent to the pyramidal tract were analyzed. Diffusion tensor imaging (TR/TE 6000/78 ms, MPG 13 axes, b-value 1000 s/mm², 128 x 128 Matrix, 2 NEX, 5 mm thickness/interleave, acquisition time 5.5 min) was performed by 1.5 T MR imager. Diffusion tensor tractography (DTT) of the pyramidal tract were visualized by the dTV and VOLUME-ONE software (Free software by Masutani Y). We evaluated the anatomical relationship between the AVMs and the tracts, shape and deformity of the tracts compared with the contralateral side, and changes of the anisotropy of the tracts. Clinical information concerning the pyramidal tracts also was reviewed.

RESULTS

The pyramidal tract could be visualized by DTT in all patients with AVMs, although some changes were observed in complicated cases. In AVMs without hematoma and/or other complications, the pyramidal tract visualized by DTT show almost normal appearance compared with the contralateral normal tract. Even in the patients with large AVM just at the portion of the pyramidal tract, the tract can be visualized through the residual white matter between the drainers and feeders with only mild shift by the mass effect of the large drainers. The anisotropy of the tract show minimal changes compared with the normal side. Functions of the pyramidal tracts were well preserved in this group. In AVMs with hematoma, radiation necrosis, and severe edema, the pyramidal tract by DTT show deformity such as moderate to severe shift, decreased anisotropy shown by change of the color (red to white), and decreased number of fibers on DTT. Diffusion anisotropy was decreased at the portion of the complications. Some functional deterioration was seen in this group.

CONCLUSION

The pyramidal tract can be visualized in patients with AVM by DTT. Visualization of the anatomical relationship between the AVM and the pyramidal tract can be useful in operation and irradiation planning.

KEY WORDS: Arteriovenous malformation, pyramidal tract, diffusion tensor imaging

Poster 68**SENSE for Diffusion Tensor Imaging of the Brain**

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PURPOSE

To evaluate sensitivity encoding (SENSE) technique for diffusion tensor imaging.

MATERIALS & METHODS

Sixteen normal volunteers underwent single-shot echo-planar diffusion tensor imaging with standard sequential and SENSE MR acquisitions with a 1.5 T Philips Intera (TR/TE = 7390 or 4331/62 ms, ETL = 127 or 67, NEX = 3, matrix = 128 x 128, FOV = 220 x 220 mm, slice thickness = 4 mm, total b value = 600 s/mm², six orthogonal diffusion gradients). With SENSE, echo train length was shortened (127 vs 67) and acquisition time was reduced from 2 min 57 sec to 1 min 22 sec for DTI. The diffusion tensor-encoded MR images were transferred to a PC workstation and analyzed with a house-made software. Fractional anisotropy (FA) and apparent diffusion coefficient (ADC) map were calculated. Image quality and presence of artifacts (ghost susceptibility, eddy current) were graded with a three-point scale. Apparent diffusion coefficient and FA were measured in the major white matter tract and gray matter nuclei. Signal-to-noise ratio also was measured. Fisher's exact test and Student's t-test were used for statistical analysis.

RESULTS

Image quality at SENSE DTI was scored significantly higher than that at standard DTI ($p < 0.05$). Susceptibility artifact (around brain stem and temporal base) and eddy current artifact was reduced significantly at SENSE DTI when compared with those at standard DTI ($p < 0.05$). Ghost artifact was not observed at SENSE DTI. Apparent diffusion coefficient value was not significantly different between SENSE DTI and standard DTI while FA value in the cerebral cortex and white matter was significantly higher at SENSE DTI than at standard DTI ($p < 0.05$). Signal-to-noise ratio was 13.44 at standard DTI and 16.20 at standard DTI.

CONCLUSION

SENSE application for diffusion tensor imaging significantly reduces geometric distortion by artifacts, shorten acquisition time, but tends to erroneously increase FA value of the tissue. Therefore, DTI with SENSE may provide better white matter fiber tracking and diffusivity indices when imaging parameters for SENSE (such as NEX) are optimized.

KEY WORDS: Brain, diffusion MR, diffusion tensor imaging

Poster 69**Line Scan Diffusion Tensor MR Imaging of Brain at 0.2 T**

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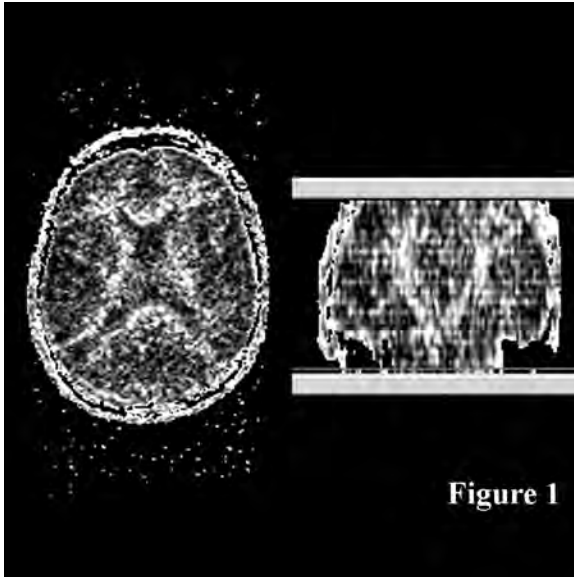
PURPOSE

The purpose of this study was to investigate and measure the values of apparent diffusion coefficients (ADC) and fractional anisotropy (FA) of diffusion-tensor MR imaging (DTI) with line scan data acquisition in the healthy human brain at 0.2 T MR imager and compared them with the values at high field strength reported in the past, as a preliminary study before its clinical use.

MATERIALS & METHODS

A total of eight healthy volunteers with no history of neurologic disease participated in this study. All MR imaging was performed on a 0.2 T MR imager (Signa Profile version 7.6, GE-YMS, Tokyo, Japan) equipped with gradients that had a maximum slew rate of 17 T/m/sec and a gradient strength of 10 mT/m with a standard head coil. To cover the whole brain, line scan diffusion-weighted imaging (LSDWI) was performed in 18 transverse sections. Line scan diffusion-weighted imaging was the line scan spin-echo sequence with a pulsed-field-gradient diffusion preparation pulse employing two different b-values (0 and 700 s/mm²) along six directions. Imaging parameters of LSDWI were as follows: TR/TE = 380/116 ms, matrix 128 x 64, bandwidth = 3.92 kHz, FOV = 300 x 150 mm, slice thickness/gap = 6/0 mm and b value of 0 and 700 s/mm² with the maximum b value applied in six directions. Subsequently, ADC maps and FA maps were calculated from the obtained LSDWI images on a pixel by pixel basis on a PC using a free software (dTV 1.5, developed by Image Computing and Analysis Laboratory, Department of Radiology, The University of Tokyo Hospital, Japan). For evaluation of ADC and FA, an region of interest

(ROI) analysis was performed. Regions of interest were placed in thalamus, genu of the corpus callosum, centrum semiovale on the images obtained with a b value of 0 sec/mm² and then were projected onto FA maps (Figure 1) and mean diffusivity maps, where ROI mean signal intensities were calculated. Areas with severe geometric distortions were excluded from the analysis.



RESULTS

All LSDWI examinations were imaged successfully. Apparent diffusion coefficient value in the thalamus is 0.78 ± 0.03 (mean $\pm$ SD); that in the genu of the corpus callosum, 0.7 ± 0.07 ; that in the centrum semiovale, 0.75 ± 0.04 . Fractional anisotropy in the thalamus is 0.38 ± 0.01 (mean $\pm$ SD); that in the genu of the corpus callosum, 0.84 ± 0.10 ; that in the centrum semiovale, 0.49 ± 0.11 . These values were comparable with the values at high field strength reported in the past literature (1).

CONCLUSION

The ADCs and FAs measured using the data obtained at 0.2 T MR imager shows the appropriate values. This means that DTI at low field strength is available for clinical use to estimate structural integrity and connectivity in the brain.

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KEY WORDS: Diffusion-weighted imaging, low field strength, tractography

Poster 70

Parametric Maps Obtained from Direct Fit of the General Kinetic Model to Dynamic-Enhanced MR Imaging Data Using the Convolution of the Measured Vascular Input Function with the Transfer Function

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PURPOSE

To present a direct method for calculating parametric maps of brain tumors from dynamic-enhanced MRI (DEMRI). The general kinetic model (GKM) of Kety describes the kinetics of contrast exchange between plasma and the extracellular space (EES) based on three parameters. Most approaches to deriving parametric maps from DEMRI data solve for these parameters by assuming a form of the vascular input function to obtain a closed form solution of the GKM. We show that a closed form solution is not necessary, and that robust estimated kinetic parameters can be derived directly from a convolution of a measured vascular input function (VIF) to the transfer function of the GKM

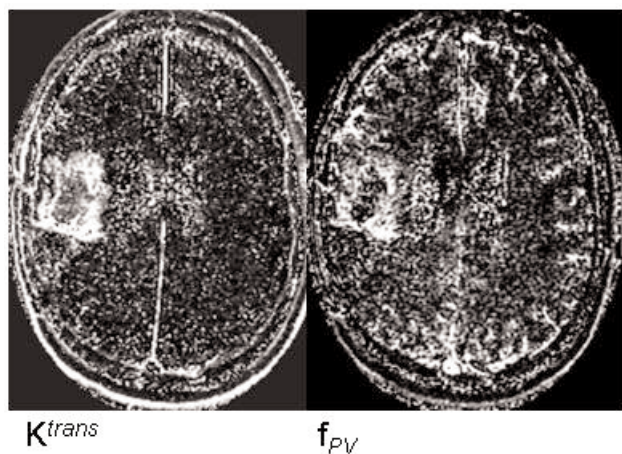
MATERIALS & METHODS

Dynamic-enhanced MR imaging in over 50 brain tumor patients was performed at 1.5 T using a 3D SPGR sequence: TR 7.2, TE 3.1, FA 30°, BW 31 kHz, FOV 22 cm, matrix 256 x 192 x 16, slab 8 cm, 20 sec. Sequential volumes were obtained for 10 min (3 volumes/min). 0.1 mmol/kg Gd-DTPA was injected i.v. @ 0.3 cc/sec @ 100 seconds. T1 mapping was performed in some cases by obtaining an additional 3D SPGR with FA 5°. Parametric maps were generated accordingly: (1) DEMRI data converted to Gd concentration ($C_{T_{measured}}$) on a pixelwise basis using assumed T1 values or from T1 mapping (if performed); (2) place an ROI on venous sinus to obtain VIF; (3) convolve the VIF ($C_{P_{measured}}$) with the GKM to obtain:

$C_{T_{estimated}} = K^{trans} (C_{P_{measured}} \otimes \exp(-k_{ep}t)) + C_{P_{measured}} f_{pv}$; (4) adjust K^{trans} , k_{ep} , and f_{pv} to obtain best fit of $C_{T_{estimated}}$ to $C_{T_{measured}}$ where K^{trans} , k_{ep} , and f_{pv} refer to the volume transfer constant from plasma to the EES, the rate constant from EES to plasma, and the fractional plasma volume.

RESULTS

Reproducible parametric maps were generated. Goodness of fit was high as assessed by C^2 values in regions of visible enhancement including tumor, vessels, and extracranial structures such as nasal mucosa and muscle. Nonenhancing portions of the brain showed uniformly low f_{pv} and K^{trans} but variable k_{ep} . Figure shows parametric maps generated in a patient with GBM.



CONCLUSION

Dynamic-enhanced MR imaging provides some information regarding the pharmacokinetics of tumor vessels and vascular permeability. Accurate and repeatable measurements are important if these measures are to be used diagnostically or as surrogate markers in clinical trials of antiangiogenic therapies. Difficulties with some pharmacokinetic models arise because the measured tissue response $C_{Tmeasured}$ is used to derive not only the parameters describing tissue response (K^{trans} , k_{EP} , f_{pV}), but also the vascular input (C_p). Because DEMRI allows a direct measurement of C_p in the brain, we show the feasibility of directly fitting the GKM to obtain tissue parameters. This approach should be robust in the face of alterations in injection strategy or hemodynamic response.

KEY WORDS: Pharmacokinetics, tumor, angiogenesis

The authors of this work have indicated the following affiliations/disclosures: General Electric Medical Systems: Employee.

Poster 71

Theory of a New RF Pulse Design for B1-Insensitive Spatially Selective Excitation with a Coil of B1-Varying-Field

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PURPOSE

Surface coils have the advantage of producing higher signal-to-noise ratio in MR experiments; however, the variation of the coil B₁ field/sensitivity along its axis concerns the reproducibility and quantitative accuracy of MR experiments. Here we describe a new RF pulse design for creating B₁-insensitive spatially selective excitation (B1ISSE) using a coil of B1-varying-field (B1VF).

MATERIALS & METHODS

The basic principle is that the RF pulse shape should be such that the pulse tips the longitudinal magnetization along the coil axis by larger and larger tip angles as the sensitivity falls off such that a constant level of transverse magnetization is created along the axis. To accomplish this, we take the recip-

rocal of the sensitivity of the coil as the working transverse magnetization profile, and then derive the pulse shape from this. Consider a circular surface coil. The sensitivity, S_c , of a circular surface coil of radius R along the coil axis, y , can be expressed as, $S_c(y) = kR^2/(R^2 + y^2)^{3/2}$ [1]. The working transverse magnetization profile, M_t , then can be obtained as, $M_t(y) = 1/S_c(y)$ [2]. When the RF pulse is applied in the presence of a linear gradient, G_y , we have, y proportional nu [3a]; $M_t(y)$ proportional $M_t(nu)$ [3b], where nu is temporal frequency. For small tip angle excitation, the desired RF pulse shape, $B_1(t) = \text{Fourier transform}[M_t(nu)]$ [4]. For large tip angle excitation, the pulse shape in Eq.4 can be optimized. The theory also can be applied to coils of other shapes such as oval or Helmholtz pair. For a Helmholtz pair, the sensitivity, $S_h(y)$, is given by, $S_h(y) = kR^2[1/(R^2 + (-D-y)^2)^{3/2} + 1/(R^2 + (-D+y)^2)^{3/2}]$ [5], where D is center-to-center distance of the Helmholtz pair of coil-radius R with currents in the same direction. The RF pulse shape then can be obtained, as before, by taking the Fourier transform of the reciprocal of the $S_h(y)$ in Eq. 5 for any arbitrary D . This may have extended applications in clinical practice, where D can be adjusted arbitrarily while still producing B₁-insensitive excitation.

RESULTS

Further Refinement and Parallel Imaging - If the same coil is used for signal reception, the received signal would be spatially nonuniform, even if the excitation is constant, along the coil axis because of variable coil sensitivity. To obtain the received signals of constant intensity, we first form a spin echo slice image of a constant spin density object (rectangular water phantom) with slice plane parallel to the coil axis and $B_1(t)$ as the excitation pulse, and then plot an image intensity profile through the center of the coil/phantom. The Fourier transform of the reciprocal of this profile would be the refined RF pulse shape, which can be modulated further using appropriate modulation functions to excite multiple slices simultaneously along the axis for SARSI parallel MR imaging (submitted to this meeting).

CONCLUSION

We described our new RF pulse design without requiring any adiabatic conditions to be met for B1ISSE with a B1VF for various applications.

KEY WORDS: New B1-insensitive, spatially selective, RF pulse

Poster 72

Validation of the Accuracy of the Spatial Normalization of the Brain Diffusion Tensor Imaging Using Statistical Parametric Mapping

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PURPOSE

The spatial normalization is the technique that transforms different size or shape of brain images from multiple subjects into a "normalized brain." This enables comparison among different brains on the same coordinate system. The statistical parametric mapping (SPM) is one of the famous software with function of the spatial normalization.

Recently, several investigators have applied SPM to the analysis of the brain diffusion tensor imaging (DTI) with spatial normalization, but there is no report evaluating its accuracy. Our purpose is to validate the accuracy and reproducibility of the spatial normalization using SPM.

MATERIALS & METHODS

Subjects include three healthy volunteers, 9 patients without obvious MR abnormality and 6 cases with chronic cerebrovascular disease (CVD). The CVD cases were examined twice with 1-3 month interval. Diffusion tensor imaging was obtained using SE type single-shot EPI sequence with 6 different directions of motion probing gradients (MPG, $b = 1000 \text{ sec/mm}^2$) as well as images without MPG. In the volunteers, DTI was performed with several different imaging parameters (various slice thickness/gap/NEX, head position). The DTI data were transferred to the workstation, and apparent diffusion coefficient (ADC) images and fractional anisotropy (FA) images were calculated. Using SPM 99, we made two different normalized images of ADC and FA and compared each other: 1) normalized ADC and FA images obtained by normalizing ADC and FA images calculated from raw DTI data set, and 2) normalized ADC and FA images directly obtained from normalized DTI data set. To validate the anatomical accuracy of the normalization, mismatch of various anatomical landmarks such as cerebral margins, central sulcus, margin of the corpus callosum, Monro foramen, pineal region, center of the middle cerebellar peduncle was measured among cases. To see whether the quantitiveness of ADC and FA values was preserved after normalization, correlation of these values between raw images and normalized images was evaluated by defining regions of interest in various structures including middle cerebellar peduncle, cerebral peduncle, basal ganglia, thalamus internal capsule, corpus callosum, and centrum semiovale.

RESULTS

Mismatch of the anatomical landmarks among the same cases with different studies (the volunteers and 6 CVD cases) was 1.2 mm in average (maximum 8 mm). The mismatch among different cases (15 clinical cases) was 2.8 mm in average (max 15 mm). The difference between the same cases and the different cases was statistically significant (Mann-Whitney: $p < .0001$). The ADC and FA values from normalized images with two different calculations were identical. There was good correlation of ADC and FA values in various structures between raw images and normalized images ($r = 0.992$ in ADC, $r = 0.989$ in FA). The correlation is almost identical in ADC but slightly underestimated in FA (slope of the regression line was 1.03 in ADC and 0.85 in FA).

CONCLUSION

Using SPM 99, DTI was well normalized anatomically with preserving quantitiveness. Application of the spatial normalization should provide reliable and subjective results in analysis of DTI data obtained from various size/shape of brain with different scan parameters.

KEY WORDS: Diffusion tensor imaging, normalization

Poster 73

Quantified Contrast Enhancement in CT Correlate with Degree of Blood-Brain Barrier Disruption of the Human Brain

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PURPOSE

The aim of the study was to detect, and to quantify by a non-invasive and commonly used imaging modality, blood-brain barrier (BBB) disruption. The BBB separates the brain's interstitial space from the blood and prevents the penetrance of circulating molecules and cells into the brain (1, 2). In most human studies, BBB permeability has been estimated using nonquantified imaging technique (3). Animal BBB disruption can be measured quantifiably utilizing an invasive technique (4, 5).

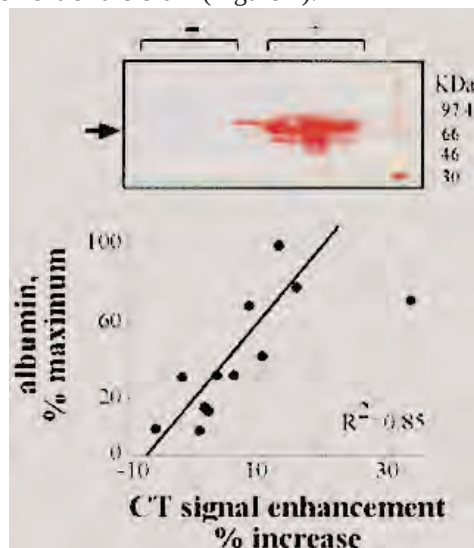
MATERIALS & METHODS

Standard pre and postcontrast brain CT had been obtained in 18 patients with various brain disorders and in a "control" group (randomly selected ambulatory patients who were referred to brain CT and had both normal neurologic examination and normal brain CT). The patients as part of their clinical investigation underwent blood and CSF lumbar tap for analysis.

Enhancement was calculated by comparing Hounsfield Unit (HU) pre and postcontrast administration in different regions of the brain and by using an image analysis program for rescaling to a colored spectrum (blue to red) between water and bone densities (0-1000 HU, respectively). Proteins in CSF were measured utilizing gel electrophoresis for albumin and incubation with antibodies selective for acetylcholinesterase AChE-R.

RESULTS

Densitometry analysis of the immunopositive albumin and ACh-R displayed positive and linear correlation with tissue enhancement of the brain (Figure 1).



CONCLUSION

We report the quantification of BBB disruption by measuring enhancement levels in CT of the brain. In this method increased level of enhancement was associated with increased albumin and Ach-R accumulation in CSF.

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KEY WORDS: Blood-brain barrier, CT, acetylcholinesterase

Poster 74

Usefulness of Phase-Contrast Cine MR in the Evaluation of Posterior Cranial Fossa Arachnoid Cysts and Mega Cisterns Magna

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PURPOSE

Conventional MR imaging falls short of a definitive evaluation between posterior cranial fossa arachnoid cysts and mega cisterns magna which affects treatment planning. Our purpose was to evaluate the values of phase-contrast cine MR imaging in differentiating posterior cranial fossa arachnoid cysts from mega cisterns magna and detecting communication between cysts and the neighboring CSF space.

MATERIALS & METHODS

Phase-contrast cine sequences were performed in 18 cases of arachnoid cysts or mega cisterns magna patients. Findings were evaluated using three standards according to the 16 phase-contrast cine images. MR phase-contrast cine diagnoses were compared to intraoperative findings and CT cisternography.

RESULTS

Six mega cisterns magna and 12 posterior cranial fossa arachnoid cysts were diagnosed. Seven arachnoid cysts communicated to the neighboring CSF space were determined further. Different manifestations were displayed on the phase-contrast cine images. Obviously reverse flow signals during the cardiac cycle were revealed in mega cisterns magna patients, and "fake septum" signs also were revealed at the axial phase amplitude images because of the different

flow in the CSF space. Jet flow signal or cranny-like hypointensity was displayed in 7 arachnoid cysts which suggested communication between arachnoid cysts and neighboring CSF space through a small cranny. Irregular flow hyperintensity was viewed in another 5 arachnoid cysts which suggested no clear communication to the neighboring CSF space. Diagnoses were verified by operation in 11 cases, by CT cisternography in 7 cases.

CONCLUSION

Phase-contrast cine sequence has important values in differentiating posterior cranial fossa arachnoid cysts from mega cisterns magna. It also can disclose the CSF pulsation amplitudes of the arachnoid cysts and visualize the communication between cysts and neighboring CSF space.

KEY WORDS: Arachnoid cyst, MR imaging, phase contrast

Poster 75

Utility of 6 Vessel Cerebral Angiography in Primary Diagnosis of Blunt Cerebrovascular Injury

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PURPOSE

Cerebrovascular injury may be an under recognized entity in blunt, high energy trauma. Incidence of carotid injury in all blunt trauma has been reported to be less than 1%, and few reliable estimates exist for incidence of vertebral artery injury. Additionally, few studies of vascular injury in blunt trauma have evaluated systematically the cerebral and cervical vasculature via angiography.

MATERIALS & METHODS

A protocol was developed to angiographically evaluate patients at high risk for blunt cerebrovascular injury. This population was defined as patients who sustained severe neck hyperextension or flexion, direct neck injury, cerebral hemorrhage of presumed carotid or vertebral origin, signs of external cervical trauma, lateralizing neurologic defect inconsistent with hemorrhage or ischemia on CT scan, cervical spine fracture, diffuse axonal injury, basilar skull fracture, or displaced midface fracture. To date, a total of 41 patients have been identified by these criteria (12 female, 29 male), and have been evaluated by 6 vessel cerebral angiography. The mechanism of blunt injury is vehicular trauma in 37/41(92%), and blunt closed head injury in 4/41(9%). All patients were evaluated initially by cervical spine and head CT. Cervical spine fractures were identified in 22 patients. Fractures through the vertebral canal were found in 13 of these patients. Fourteen patients had significant skull base fractures involving the bony elements of the carotid canal. Vertebral artery injury including dissection and occlusion was angiographically identified in 6/41(15%), and carotid artery injury including dissection, occlusion, pseudoaneurysm formation, and cavernous carotid fistula formation was identified in 8/41(20%). Outcome data including the incidence of stroke, and need for anticoagulation were also examined. Among patients with vertebral artery injury, stroke occurred in 1/6(16%) and 4/6(66%) had significant

injuries warranting anticoagulation. Among patients with carotid injuries, 5/8(63%) had radiographic evidence of stroke, and 5/8(63%) had significant injuries requiring anticoagulation. Chi-square analysis was used to examine the relationship between carotid and vertebral artery injury and other radiographic markers of blunt trauma including skull base fracture, cervical transverse foraminal fracture, cervical facet joint fracture, multilevel cervical spine fractures, and cerebral hemorrhage.

RESULTS

A significant association between vertebral injury and cervical facet joint fracture was identified ($p < .005$). A subset of the patient population in this study received additional vascular imaging (CTA or MRA).

CONCLUSION

Sensitivity and specificity estimates for vascular injury by these modalities when compared with cerebral angiography will be provided. Cerebrovascular injury is associated with a high rate of morbidity. Among patients with high energy mechanisms of blunt injury, cerebral angiography may be warranted as a primary diagnostic imaging modality given the relatively high incidence of vascular injury in this population.

KEY WORDS: Cerebral angiography, carotid injury, vertebral dissection

Poster 76

Cerebrospinal Fluid Activated Caspase-3 and bcl-2: Evidence for Involvement in the Neurologic Outcome in Human Traumatic Brain Injury

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PURPOSE

Caspase-3, a marker of apoptotic cell death, is expressed in human and animal traumatic brain injury. Expression of bcl-2 promotes cell survival by opposing some stimuli known to induce cell death. We tested the hypothesis that increased cerebral spinal fluid (CSF), activated caspase-3, and decreased levels of CSF bcl-2 are associated with poor neurologic outcome.

MATERIALS & METHODS

Ten adult patients with severe traumatic brain injury (TBI) (Glasgow Coma Scale (GCS) < 8) admitted to the University of Maryland Shock Trauma Center. All patients with closed head injury and no evidence of hypoxic brain injury underwent clinical and radiographic evaluation and placement of an intraventricular catheter for monitoring and management of increased intracranial pressure. Cerebral spinal fluid was sampled at the time of insertion and at defined intervals of 6, 12, 24, and 48 hours. The CSF samples were frozen in liquid nitrogen (-70°C). Controlled CSF samples were obtained from healthy patients ASA1 undergoing spinal anesthesia for elective surgical procedures. Head CT was obtained at admission, and as clinically indicated. Cerebral spinal fluid levels of bcl-2 were measured using Elisa, bcl-2 Elisa (Oncogene Research Products). Activated caspase-3 was measured

using Elisa (R&D) systems. Neurologic follow-up was performed for 1 month after the injury. Poor outcome was defined as GCS < 5 or death.

RESULTS

Six patients had poor outcome. Active caspase-3 is increased in all patients with poor outcome (70.8-85.1 ng/ml). The standard range for caspase-3 is 0.3 to 20 ng/ml. The increased levels were detected more than 12 hours after TBI. bcl-2 was not increased in either group. The standard range of bcl-2 is 5.1 to 20 ng/ml. Initial CT findings had low predictive value for functional outcome.

CONCLUSION

An increased level of activated caspase-3 is associated with poor neurologic outcome. Low levels of bcl-2 were detected in both groups. Development of imaging modality to evaluate apoptotic brain injury in trauma patients could detect patients with potential for poor neurologic outcome.

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KEY WORDS: Activated caspase-3, bcl-2, apoptosis

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Poster 77

Extracranial Carotid Angioplasty and Stenting: Angiographic and Clinical Outcome

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PURPOSE

To assess angiographic and clinical outcome in high risk, NASCET ineligibility, patients with extracranial carotid stenoses treated with angioplasty and/or stenting.

MATERIALS & METHODS

From September 1993 to October 2003, carotid arterial stent placement and/or angioplasty were attempted in 78 patients (47 males and 31 females; average age 71 years, age range: 36-91 years) in 88 stenotic extracranial carotid arteries. All patients were considered to be high risk and NASCET ineligible. Patients were placed under either general endotracheal anesthesia for the procedure unless contraindicated due to cardiopulmonary disease. Postprocedure, all patients received antiplatelet therapy for 2 months including ticlid and aspirin or plavix and aspirin followed after 2 months by aspirin alone. Imaging follow-up consisted of CT angiography, MR angiography, carotid ultrasound, or conventional angiography. Significant restenosis was considered to be 70% or greater narrowing in the treated vessel. Repeat procedure was undertaken in patients with significant restenosis.

RESULTS

The average pretreatment stenosis was 86% (range: 50%-100%). Sixty-seven out of 78 (86%) patients presented to us with significant neurologic symptoms (e.g., TIAs). There were two failed treatment attempts. They were both due to failure to access the lesion. The average postoperative stenosis was 8.7%. Procedural-related mortality was zero. Imaging (CTA, MRA, ultrasound, conventional angiography) and/or clinical follow-ups were obtained for 69 out of the 88 procedures with a mean follow-up time of 12 months. Imaging follow-up is available in 47 arteries. Significant stenoses ($\geq 70\%$) were seen in 13 out of these 47 cases (28%). Sixteen patients underwent repeat treatment(s) due to restenosis. Clinical follow-up information is available in 45 cases. In most of these cases (34/45, 75.6%), patients experienced minimal or no neurologic symptoms. In 8 cases (17.8%), patients experienced clinically significant symptoms (e.g., TIAs). Finally, the remaining 3 patients (6.7%) died of causes unrelated to the procedure.

CONCLUSION

Angioplasty and/or stenting are both safe and efficacious in treating extracranial carotid stenoses for high risk, NASCET ineligible patients.

KEY WORDS: Stenosis, angioplasty, stenting

Poster 78**Vertebral Venous System in Relation to Cerebral Venous Drainage on MR Angiography**

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PURPOSE

In the supine position, cerebral venous drainage occurs primarily through the internal jugular veins, as seen on venous phase cerebral angiography. However, in the erect position, the vertebral venous system (VVS) represents the major alternative pathway of cerebral venous drainage and that outflow through the internal jugular veins is absent or negligible. The purpose of this study is to evaluate the VVS and relationship between the surrounding venous structures and it on MR angiography (MRA) in the supine position.

MATERIALS & METHODS

We retrospectively reviewed 65 patients (M:F = 31:34, mean age = 61.6 years) who underwent multiphase contrast-enhanced carotid MRA. Imaging studies were performed using a 3.0 T MR unit (TR: 5.2, TE: 1.1, FA: 20, 3.8 thickness, EC: 1). We analyzed appearance and extent of the VVS (vertebral venous plexus and vertebral artery venous plexus) and the internal jugular vein on venous phase. We also evaluated main drainage pattern of cerebral venous drainage and drainage pattern of the VVS. Visualized the VVS were defined poor, vertebral venous plexus dominant, vertebral artery venous plexus dominant and mixed.

RESULTS

In the VVS, the vertebral artery venous plexus was visualized in 54 cases (54/65, 83%). The appearance of visualized vertebral artery venous plexus was symmetrical in 39 cases (39/54, 72%) and asymmetrical in 15 case (15/54, 28%). The extent of visualized vertebral artery venous plexus was partial in 26 cases (26/54, 48%) and complete in 28 case (28/54, 52%). The vertebral venous plexus was visualized in 62 cases (62/65, 95%). The appearance of visualized vertebral artery venous plexus was symmetrical in 43 cases (43/62, 69%) and asymmetrical in 35 case (19/62, 31%). The extent of visualized vertebral artery venous plexus was partial in 35 cases (35/62, 56%) and complete in 27 case (27/62, 44%). The appearance of visualized internal jugular vein was asymmetrical in 44 cases (44/65, 68%) and symmetrical in 21 cases (21/65, 32%). Of the 44 asymmetrical cases, 4 cases demonstrated partial nonvisualization of the internal jugular vein. The 4 cases had well visualized the ipsilateral VVS. Main cerebral venous drainage occurred through the internal jugular vein in 62 cases (63/65, 97%) and the VVS in 3 cases (3/65, 3%). Drainage pattern of the VVS was poor in 14 cases (14/65, 21%), vertebral venous plexus dominant in 11 cases (11/65, 17%), vertebral artery venous plexus dominant in 18 cases (18/65, 28%) and mixed in 22 cases (22/65, 34%).

CONCLUSION

In the supine position, the VVS was well visualized. The VVS was an alternative collateral pathway of the internal jugular vein in cerebral venous drainage. The internal jugular vein and the VVS may vary inversely.

KEY WORDS: MR, vein, blood, flow

Poster 79**Carotid MR Angiography with Three-Dimensional Balanced Turbo-Field Echo Technique: Comparison with Three-Dimensional Time-of-Flight Technique**

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PURPOSE

Three-dimensional balanced turbo-field echo (b-TFE) technique, one of the steady-state free precession imaging, can acquire vascular imaging in shorter time than conventional

gradient-echo acquisition. The purpose of this study was to evaluate feasibility of the b-TFE technique for cervical carotid MR angiography (MRA) in comparison with the three-dimensional (3D) time-of-flight (TOF) MRA.

MATERIALS & METHODS

As the first step, five normal volunteers (10 carotid arteries; 4 men and 1 woman; age 21-55 years; mean, 39.2 years) underwent both carotid MRA with b-TFE (4.7/2.3/100; TR/TE/FA) and carotid ultrasonography. Carotid diameter measured was compared between MRA and ultrasonography. Second, 13 patients (26 carotid arteries, 5 men, 8 women, age 22-83 years, mean, 59.6 years, 2 acute stroke patients, 11 nonstroke patients) underwent both 3D TOF (23/3.1/22) and 3D b-TFE MRA (4.5/2.3/100). In both techniques, parallel imaging was applied (SENSE factor = 1.2). The image acquisition time was 1 min 54 sec for b-TFE and 3 min 55 sec for TOF. Spatial resolution was 1.25 x 1.25 x 1.5 mm in b-TFE and 0.59 x 1.02 x 1.5 mm in TOF. Both MR imaging were compared using the following evaluations: 1) visualization of carotid bifurcation, common carotid artery, internal carotid artery, external carotid artery and their branches, 2) signal loss at the carotid bifurcation, 3) artifact other than flow related artifact. In two stenotic lesions, delineation of stenosis also was compared.

RESULTS

The diameters of common carotid and internal carotid arteries measured were well correlated between b-TFE and ultrasonography. Delineation of each carotid artery was equal in both imaging technique. In three younger patients, the TOF technique showed more prominent signal loss at the carotid bifurcation than for b-TFE. Visualization of branches was better in b-TFE. In two stenotic lesions, degree of stenosis was visualized equally for both techniques. Some veins adjacent to the carotid arteries were visualized in b-TFE.

CONCLUSION

Three-dimensional b-TFE MRA can provide carotid imaging of equal quality to 3D TOF MRA in significantly shorter imaging time. Further investigation in patients with various degrees of carotid stenosis will be needed.

KEY WORDS: Carotid MRA

Poster 80

Surface Appearance of the Vessel vs MR Angiography: Basi-Parallel Anatomical Scanning MR Imaging for the Accurate Evaluation of the Intracranial Vertebrobasilar Artery

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PURPOSE

Basi-parallel anatomical scanning (BPAS) MR imaging is a simple MR technique that we designed for visualization of the surface appearance of vertebrobasilar artery within the cistern (1). Basi-parallel anatomical scanning MR imaging can clearly show the outer contour of occluded arteries or

thrombosed aneurysms. The purpose of this study is to determine the value of BPAS MR imaging for the brain screening MR examination.

MATERIALS & METHODS

Basi-parallel anatomical scanning MR imaging means heavily T2-weighted thick coronal scanning with gray-scale reversal in postprocessing (Figure). We performed BPAS MR imaging in a 20 mm thick coronal section parallel to the clivus using fast spin-echo sequence (TR/TE/excitations: 6000/250/2, FOV: 19 x 19 cm, matrix: 384 x 224) on a 1.0 T scanner (GE, SIGNA Horizon LX). Both BPAS MR imaging and 3D TOF MRA obtained in 385 consecutive patients for 6 months. Comparing BPAS MR imaging with MRA, we determined the role and value of displaying vascular outer contour.

RESULTS

Unilateral vertebral artery (VA) was not shown on MRA in 56/385 patients (14.5%). Basi-parallel anatomical scanning MR imaging confirmed hypoplastic unilateral VA in 30/56 patients (54%). Basi-parallel anatomical scanning MR imaging also revealed the occlusion of the unilateral VA of normal diameter in 26/56 patients (46%). Ten aneurysms of vertebrobasilar system were detected on MRA and/or BPAS-MR imaging. The shape of aneurysm depicted on MRA was different from its outer contour shown on BPAS-MR imaging in 8/10 aneurysms.



CONCLUSION

Basi-parallel anatomical scanning MR imaging was necessary for the accurate diagnosis in 16% of our series. We should evaluate not only MRA but also the vascular outer contour of the vertebrobasilar artery because we can easily obtain its outer appearance by BPAS- MR imaging.

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KEY WORDS: MR imaging, vertebrobasilar system

Poster 81

Gadolinium Contrast CT Angiography of the Circle of Willis and Neck

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PURPOSE

CT angiography (CTA) of the cervical and intracranial vessels is a rapid, noninvasive, and relatively inexpensive technique for the evaluation of vascular abnormalities. However, contraindications to the use of contrast can preclude use of iodinated agents for CTA. We report the use of gadolinium as contrast agent for CTA of the head and neck in three patients with contraindications to iodinated contrast.

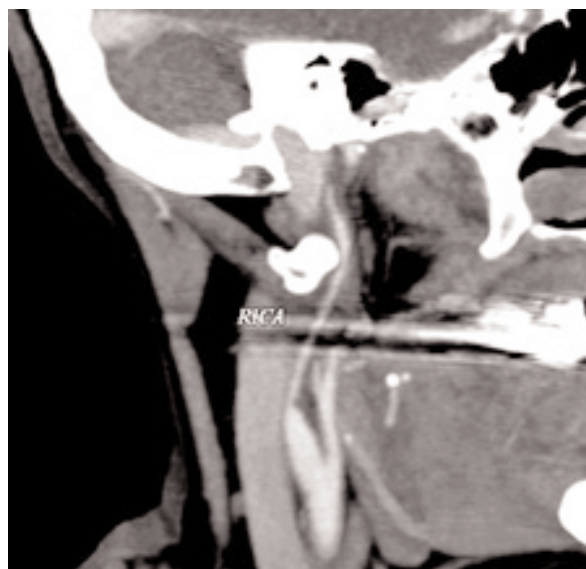
MATERIALS & METHODS

CTA imaging was acquired on a 16-detector multislice helical scanner using a 25 second delay after contrast administration, 140 kVp, 170 mA, 0.8 second rotation time, 1.25 mm slice thickness reconstructed at 0.6 mm intervals, 3.75 mm/rotation table speed, pitch 0.75:1, and soft tissue algorithm reconstruction. Instead of iodinated contrast material, a power infusion of 60 ml of gadopentetate was followed by a 20 ml normal saline chase, both injected at 4 ml/s through an 18-gauge cannula placed into an antecubital vein.

RESULTS

A 63-year-old man entered the emergency department with 30 minutes of the severe right retro-orbital headache and a question of unruptured aneurysm. The patient had a permanent cardiac pacemaker and a history of anaphylaxis following the administration of iodinated CT contrast. CTA images demonstrated no evidence of an intracranial aneurysm. A 52-year-old woman with severe complications from diabetes, including renal failure treated with renal transplant, had an MRA which suggested carotid dissections. Iodinated contrast was contraindicated because of moderate chronic renal insufficiency in setting a renal transplant. A gadolinium-enhanced CTA of the cervical vessels and circle of Willis suggested complete occlusion of the left internal carotid artery and severe stenosis of the right internal carotid artery with tapered narrowing indicating the presence of carotid dissections (Figure). A 71-year-old man with an automatic

implantable cardiac defibrillator placement, diabetes, and chronic renal insufficiency developed acute onset of expressive aphasia without other symptoms. The patient had a history of a "carotid plaque" and concerns were raised about the possible need for urgent carotid endarterectomy. Iodinated contrast was contraindicated because of chronic renal insufficiency with a history of prior exacerbation after use of iodine contrast. A gadolinium-enhanced CTA of the cervical vessels revealed only mild stenosis of the left carotid bifurcation with scattered atherosclerotic calcification and a hypodense plaque. In all three cases subjective image quality, although inferior to that of conventional CTA, was considered diagnostically adequate. Contrast density within the cervical and intracranial arteries was between 94 and 150 Hounsfield units, which is one third to one half of the typical values for iodinated contrast CTA.

**CONCLUSION**

Gadolinium-enhanced CTA for vessels of the head and neck is technically feasible and is valuable in patients with contraindications to use of iodinated contrast.

KEY WORDS: CTA, gadolinium, contrast

Poster 82

Hypertensive Encephalopathy: An Investigation into the Role of Endothelial Dysfunction

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PURPOSE

To use von Willebrand's antigen (vWAg), a specific marker of endothelial damage, to determine whether damage or dysfunction of the vascular endothelium plays a role in the development of hypertensive encephalopathy (HTE).

MATERIALS & METHODS

Over a five-year period, we studied sixty-eight patients with acute hypertension who developed clinical signs suggestive of HTE (severe headache, seizures and/or visual changes)

and in whom von Willebrand's antigen (vWAg) was measured. Fifty patients had MR findings of edema in the occipital lobes (HTE) and eighteen had normal scans (hypertensive non-HTE). The level of vWAg was measured in each patient within 24 hours of the neurologic event. For each patient, the mean arterial blood pressure at the time of the neurological event [MAP (event)] was recorded, as was baseline blood pressure at a time remote from the neurologic event [MAP (bl)]. The difference [MAP (diff)] was calculated. The mean age, vWAg level, MAP (event), MAP (bl), and MAP (diff) was compared between the two groups using the Student's *t*-test. *P* values less than 0.05 were considered statistically significant. In addition, the vWAg values from each patient group were submitted to correlational analysis with the MAP (event) and MAP (diff) using the Pearson's product moment correlation statistic.

RESULTS

There was no significant difference between the mean ages of the two groups (HTE: 48 ± 16 years, non-HTE: 43 ± 17 years) or the baseline MAPs (HTE: 93 ± 11 mm Hg, non-HTE: 90 ± 15 mm Hg). The average vWAg levels in the group of patients who developed HTE was 258 ± 82 U vs 203 ± 78 U in the hypertensive non-HTE group. This difference was significant ($p = 0.018$). There was no significant difference in the average MAP (event) of the patients who developed HTE (138 ± 21 mm Hg) and in those who did not develop HTE (127 ± 19 mm Hg). The average MAP (diff) was 44 ± 17 mm Hg in the HTE group vs 37 ± 16 mm Hg in the hypertensive non-HTE group. This difference was not statistically significant. There was no correlation between vWAg and MAP (event) or MAP (diff) in either group.

CONCLUSION

Our results suggest that acute hypertension by itself may not be sufficient to produce HTE; endothelial damage also likely plays a role in the development of the syndrome. It is not clear whether endothelial damage is a primary cause of HTE or is a consequence of the systemic hypertension that is responsible for HTE. However, the absence of correlation between levels of vWAg and MAP (event) suggests that endothelial dysfunction may be a distinct factor, separate from systemic hypertension, in the development of HTE.

KEY WORDS: Hypertensive encephalopathy, von Willebrand's antigen

Poster 83

Detection and Characterization of Anterior Cerebral Artery Aneurysms by Using 2D and 3D Helical CT Angiography in Emergent Aneurysm Clipping

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PURPOSE

Cerebral subarachnoid hemorrhage may result from rupture of saccular aneurysms in the anterior cerebral artery (exclusion of anterior communicating artery). The purpose of this study was to evaluate the usefulness of helical CT angiography (CTA) in detection and characterization of intracranial aneurysms at such an uncommon location.

MATERIALS & METHODS

Between 1998 and 2003, fifty consecutive patients who had undergone emergent aneurysm clipping for intracranial aneurysms were reviewed. Nineteen patients of the fifty with aneurysms occurred in the anterior cerebral artery. After exclusion of those patients with typical anterior communicating artery aneurysms, there were nine aneurysms with uncommon location recruited in this study. Plain CT and CTA in all of the nine aneurysms and digital subtraction angiograms (DSA) in four of nine aneurysms were reviewed blindly by two radiologists. Interpretation included aneurysm detection, quantification, and characterization using 2D multiplanar reformatted and 3D volume-rendering techniques.

RESULTS

All nine aneurysms were detected preoperatively by CTA and all were confirmed at surgery and/or angiography. There were two small aneurysms from A1 segment, one from A2 segment, two at the junction of triplicated anterior cerebral arteries, two at the junction of A2-3 segment, one at the junction of A2-3 segment of azygos ACA, one from the distal branch of ACA. The average maximal aneurysm sac diameter was 4.39 mm (range, 2.7-7.0 mm). The average aneurysm neck size was 2.52 mm (range, 1.2-3.5 mm). The smallest aneurysm was located in the A1 segment of left anterior cerebral artery and measured $2.2 \times 1.8 \times 2.7$ mm, with a neck measured 1.2 mm. On plain CT, four of nine had intracranial hematoma, eight of nine had intraventricular hemorrhage and three of nine had acute hydrocephalus.



CONCLUSION

The aneurysms of anterior cerebral arteries are usually smaller and associated with complex vascular structures which wrapped around the aneurysms. The sensitivity of CTA for the detection and characterization of ACA aneurysm in uncommon location is at least equal to DSA, with better demonstration of the body and neck of an aneurysm and adjacent complex vascular anatomy. In an emergent situation, such as deteriorating patients with an intracranial hematoma or acute hydrocephalus, noninvasive CTA can offer a useful diagnostic modality.

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KEY WORDS: Aneurysm, anterior cerebral artery, CT angiography

Poster 84

Acute Hematoma and Perihematoma Cerebral Blood Flow Changes as Measured by CT Perfusion

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PURPOSE

In this study we sought to quantify cerebral blood flow (CBF) changes within and around acute spontaneous intracerebral hemorrhage (SICH) by using deconvolution-derived CT perfusion hemodynamic imaging.

MATERIALS & METHODS

The perfusion studies were performed by using a single-section CT scanner (CT Hispeed ZX/i; General Electric Medical Systems, Milwaukee, WI) equipped for CT perfusion imaging (CT Perfusion; General Electric Medical Systems, Milwaukee, WI) in 40 patients (19 male and 21 female; mean age = 69.07 ± 10.17 years) with supratentorial acute SICH at admission CT and having a Glasgow Coma Scale at entry ranging from 12 to 15. All CT perfusion scans were obtained within 24 hours after symptom onset and analyzed with a deconvolution-based algorithm by using an imaging workstation (Advantage Windows; General Electric Medical Systems, Milwaukee, WI). Cerebral blood flow, cerebral blood volume (CBV), and mean transit time (MTT) perfusional maps were generated for each patient. Regional CBF (rCBF), CBV (rCBV), and MTT (rMTT) levels were measured in three different regions of interest (ROI) larger than 1 cm² and manually outlined on the baseline diagnostic CT scan: 1) hemorrhagic core; 2) perihematoma low density area; 3) 1 cm of normal appearing brain tissue surrounding

the perilesional low density area. An additional ROI mirrored the region including the clot and perihematoma low density area was placed in the contralateral hemisphere. Cerebral blood flow, CBV, and MTT values were expressed in ml/100 g/min, ml/100 g and seconds, respectively. Statistical analysis was performed by Mann-Whitney U test.

RESULTS

Regional cerebral blood flow and rCBV mean levels were lower in hemorrhagic core than in perihematoma low density area ($p < 0.001$), in perihematoma low density area than in normal appearing area ($p < 0.001$), and in both hemorrhagic core and perihematoma area than in contralateral ROI ($p < 0.001$). Regional cerebral blood flow and rCBV mean levels were similar in normal-appearing and contralateral areas. Regional mean transit time mean values were higher in perihematoma low density area than in normal appearing area ($p < 0.01$) and in both hemorrhagic and perihematoma area than in contralateral ROI ($p < 0.001$). There was no differences for rMTT mean values between hemorrhagic core and perihematoma area, as well as between normal-appearing and contralateral areas (Table).

CT Perfusion Maps	Regions of Interest (ROI)			
	Core	Perihematoma Area	Normal Appearing	Contralateral Area
CBF (ml/100g/min)	10.909±7.034	35.661±16.262	72.485±54.357	71.025±35.663
CBV (ml/100g)	0.868±0.465	2.299±0.955	3.837±2.433	3.777±1.699
MTT (sec)	5.861±2.191	5.506±1.520	4.501±1.307	4.169±0.997

CONCLUSION

Our findings suggest that dynamic CT perfusion scanning with deconvolution analysis is a promising method for the evaluation of perfusional disturbances associated to acute SICH and indicate that perfusional parameters are distributed concentrically and gradually improve from the core to the periphery. We found perfusional ischemic values in hemorrhagic core, whereas perihematoma area showed hypoperfusional levels reflecting edema formation, but not ischemic penumbra. In addition, hyperperfusional levels were observed in normal-appearing brain tissue located both ipsilaterally and contralaterally to hematoma.

KEY WORDS: Acute hematoma, cerebral blood flow, CT perfusion

Poster 85

Comparing CT Angiography and Digital Subtraction Angiography in the Detection of Intracranial Aneurysms

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PURPOSE

CT and intracranial aneurysm digital subtraction angiographic (IADSA) examinations were compared for sensitivity and specificity of detection of intracranial aneurysms in acute subarachnoid hemorrhage, and to determine whether CT angiography could be the sole sufficient method replacing IADSA.

MATERIALS & METHODS

Sixty-eight patients with acute subarachnoid hemorrhage were angiographically examined with a multislice CT scanner (data acquisition: 4-row adaptive array detector; data reconstruction: axial thin slice reconstruction, multidirectional maximum intensity projections (MIPs), shaded surface display) and a consecutive IADSA before initiating a therapeutic decision towards endovascular or operative treatment of intracranial aneurysms. Sac/neck ratios were calculated from CT MIPs in all aneurysm-bearing patients.

RESULTS

Sensitivity of CT angiography was 96.8% with 63 aneurysms in 56 patients. Specificity was 100% in 12 patients without aneurysms (six of these patients suffered from prepontine hemorrhages). True 3-dimensional expansion of the aneurysms was detected by either method (isotropic CT imaging and multiplanar IADSA projections). Two questionable sac/neck CT analyses turned out to be large necks in IADSA.

CONCLUSION

In case of correlation of bleeding site and aneurysm localization, the high sensitivity of multislice CT angiography can detect sufficiently the presence of wide-necked aneurysms preoperatively in patients with acute subarachnoid hemorrhage. In cases of noncorrelation, the additional use of IADSA may reveal the true origin of hemorrhage. In cases of questionable sac/neck ratios in MIPs (selective) IADSA is necessary to increase architectural information for decision on the appropriate therapeutic modality. Three-dimensional configuration of aneurysms and their operative approaches are very well imaged in CT-shaded surface display reconstruction. The lack of imaging preinfarct vasospasm in subarachnoid hemorrhage is an unresolved problem in CT angiography without the use of CT perfusion technique. Although attempts to optimize diagnosis of aneurysmatic disease, by using multislice techniques, have resulted in improvement of detection and imaging, so far, CT angiography can not replace IADSA completely.

KEY WORDS: CT angiography, aneurysm

Poster 86

Cyclosporin A/FK-506 Neurotoxicity, Preeclampsia/Eclampsia and PRES Syndrome: Different Names but Similar Systemic Pathophysiology

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PURPOSE

Neurotoxicity in preeclampsia/eclampsia or after the administration of the immune suppression drugs Cyclosporin A (CsA) and FK-506 are evaluated frequently together because of a similar brain imaging appearance and presence of hypertension. This is often labeled the posterior reversible encephalopathy syndrome (PRES) syndrome. There are many systemic biological parallels between these conditions suggesting a more generic underlying pathophysiology leads to the imaging features. These drugs are used to control

transplant rejection or graft vs host disease and in many ways, the fetal-placental unit could be viewed as a partially matched transplant. The purpose of this study is to review the underlying biology of CsA/FK-506 toxicity and preeclampsia/eclampsia to better characterize their systemic similarities and differences.

MATERIALS & METHODS

The relevant literature related to CsA/FK-506 toxicity, preeclampsia/eclampsia and the PRES syndrome were reviewed and clinical/biological similarities and differences were noted.

RESULTS

Evidence of endothelial cell injury is present in both groups with release of endothelial cell surface molecules or subendothelial cell matrix components (thrombomodulin, fibronectin) and evidence of microvascular red blood cell damage (shistocytes, hemolysis with LDH release). Renal glomerular, tubular and vascular injury develops with glomerular endothelial swelling (capillary endotheliosis), proteinuria and reno-vascular spasm with renal hypo-perfusion. Endothelial cell activation occurs due to release of cytokines (tumor necrosis factor, interleukin 1, interferon gamma) with resultant up-regulation of vasoactive substances (endothelin) as well as cell surface proteins and the development of endothelial leakage. Cell surface marker up-regulation leads to inflammatory cell adherence and further endothelial injury along with altered endothelial cell permeability. Proteinuria in combination with altered endothelial cell permeability leads to systemic edema. The coagulation system is activated with resultant platelet consumption and thrombocytopenia in both groups. Altered platelet adherence with release of vasoactive agents along with up-regulation of endothelin likely leads to marked alteration in systemic vascular tone and resistance. The resultant vascular instability with resultant variable expression of hypertension, vasospasm, sympathetic vascular reactivity and altered response to vasopressor agents is the likely common outcome in both groups. Immune system alteration occurs in patients with transplantation and preeclampsia/eclampsia and is represented widely in the patients who develop the otherwise labeled PRES syndrome (lupus, scleroderma, Wegener's). The effects of transplantation (marrow or solid organ) lead to a complex immune response with attempted transplant or host rejection. Endothelial cell antibodies are common in solid organ rejection and are elevated in preeclampsia. With the development of severe toxicity, a similar pattern of systemic effects are seen in both groups with the development of the HELLP syndrome (hemolysis, elevated liver enzymes, low platelets) in patients with preeclampsia/eclampsia and the development veno-occlusive disease of the liver, bone marrow transplant thrombotic microangiopathy and endothelial leakage syndrome (all potentially related to graft vs host disease) in patients with allogeneic marrow transplantation.

CONCLUSION

The underlying systemic biological and physiologic processes occurring in patients with CsA/FK-506 toxicity, preeclampsia/eclampsia and PRES syndrome are similar. These systemic processes likely contribute to the development of neurotoxicity and the imaging appearance we ultimately observe.

KEY WORDS: Cyclosporin A neurotoxicity, eclampsia, PRES

Poster 87**Three-Dimensional Subtraction Venography of the Brain with a Volumetric Interpolated Sequence**

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PURPOSE

Three-dimensional (3D) gradient-echo MR sequences can be optimized for rapid acquisition through asymmetric k-space sampling and interpolation. A T1-weighted volumetric interpolated brain examination (VIBE) sequence was compared with a magnetization-prepared rapid acquisition gradient-echo (MP-RAGE) sequence for subtraction venography of the cerebral venous structures.

MATERIALS & METHODS

Twenty-eight patients were examined with MP-RAGE (acquisition time 6.06 min) and VIBE (acquisition time 1.24 min) subtraction venography. Pre and postgadolinium subtracted source images and MIP images were used for analysis. Signal-to-noise ratio (SNR) in the superior sagittal sinus (SSS) and greater cerebral vein (GCV), and CNR for SSS and GCV vs white (WM) and gray matter (GM) were compared. Image quality of multiple venous structures was scored on a 1-4 scale and compared for the two techniques. The number of visualized cortical veins also was compared.

RESULTS

On the source images, SNRs for SSS and GCV, and CNRs (contrast-to-noise ratio) for veins/GM and veins/WM were significantly lower for the VIBE sequence ($p < 0.05$). Qualitatively, there was no statistically significant difference for the subjective visualization scores assigned to each technique ($p < 0.05$). There was no statistically significant difference for the number of visualized cortical veins ($p < 0.05$).

CONCLUSION

Although SNR and CNR are substantially lower there was no statistically significant difference in the subjective visualization scoring of the cerebral venous structures. Therefore VIBE can be used as a more time efficient alternative approach to MP-RAGE for 3D imaging of the cerebral venous structures.

KEY WORDS: 3D gadolinium-enhanced MR angiography, VIBE venography, MP-RAGE venography

Poster 88**Corpus Callosum Hematoma Due to Isolated Inferior Sagittal Sinus Thrombosis**

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PURPOSE

Isolated inferior sagittal sinus thrombosis is an extremely rare phenomenon. We found only one case report in literature; which had published in *Neuroradiology* by Elsherbindy, et al. We report a case with hematoma in splenium of corpus callosum due to isolated inferior sagittal sinus thrombosis.

MATERIALS & METHODS

Forty-five-year-old female was referred to the hospital with vomiting, confusion, and temporary loss of consciousness. CT examination demonstrated the hematoma in splenium with moderate edema halo and hemorrhagic densities at bilateral cingulate gyri. Other findings were noted as normal. The patient underwent MR and MR angiography examinations. On MR imaging, a large hematoma in the splenium of corpus callosum with edema halo, cingulate hemorrhage and some nonspecific, probably ischemic bright spots were noted. On FSE T2-weighted and SPGR T1-weighted images, the normally expected signal voiding was not found in the inferior sagittal sinus localization. PC MR angiography showed that there was no flow in the inferior sagittal sinus. Other cerebral venous sinuses were found to be patent. Digital subtraction angiography examination confirmed these findings. The final radiologic diagnosis was isolated inferior sagittal sinus thrombosis and secondary hemorrhagic infarcts in corpus callosum and both cingulate gyri.

RESULTS

Focal infection (pyelonephritis) was documented with laboratory results. After hospitalization and medical treatment was given, clinical and radiologic findings revealed slowly. The patient was discharged with oral antiaggregating therapy. On control MR examinations, only a mild ischemic focus in splenium was rested. The venous flow in inferior sagittal sinus was restored.

CONCLUSION

Cerebral venous thrombosis and accompanying hemorrhagic infarcts are not uncommon in routine radiologic practice; especially in transverse sinus, deep cortical veins, partial thrombosis in superior sagittal sinus, and a combination of these. Sinus thrombosis is reported to be responsible for about 10% of all ischemic lesions. The clinical presentation, etiology, treatment and outcome are highly variable. Association with hypercoagulopathy, cancer, infections with or without dehydration, thyrotoxicosis have been documented (our patient had an urinary tract infection). Diagnosis could be done clinically; proven by MR angiography and DSA. Rapid diagnosis and early treatment is crucial. But, isolated inferior sagittal sinus thrombosis is extremely rare. Atypical corpus callosum hematoma in

patients with acute neurologic symptoms such as loss of conscious, seizures must be considered for isolated inferior sagittal sinus thrombosis.

KEY WORDS: Cerebral venous sinus thrombosis, corpus callosum hematoma, hemorrhagic infarct

Poster 89

MR Angiography Image-Guidance for the Microsurgical Clipping of Intracranial Aneurysms

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PURPOSE

To describe the method and the potential interest of integrating MR angiography (MRA) in neuronavigation procedures for microsurgery of intracranial aneurysms (IA).

MATERIALS & METHODS

MRA was combined with standard MR image acquisition in the image-guided planning for the microsurgical clipping of a saccular aneurysm in 2 patients (one 3 mm large middle cerebral artery and one 8 mm large pericallosal artery aneurysm, diagnosed by catheter angiography in both patients) using two different neurosurgical navigation systems (Zeiss MKM microscope, Carl Zeiss, Oberkochen, Germany and StealthStation Treon, Medtronic Surgical Navigations Technology, Louisville, CO). Conventional 3D-T1-weighted MR imaging (TR/TE: 5.9/1.6 msec; flip angle 35°; FOV: 300 mm; matrix: 228 x 512; 122 slices; thickness: 1.8 mm reconstructed with an overlap of 0.9 mm between slices) with gadolinium (2.5 ml/sec), and MRA pulse sequences consisting in axial 3D magnetization transfer (MT)-tilted optimized nonsaturating excitation (TONE) (TR/TE: 31/3.4 msec; flip angle 28°; FOV: 300 mm; matrix: 261 x 512; 96 slices; thickness: 1.6 mm reconstructed with an overlap of 0.8 mm between slices) were acquired in frameless stereotactic conditions the day before surgery on a 1.5 T magnet (Gyrosan, Intera, Philips Medical Systems, Best, The Netherlands) using skin-based markers. Both images were coregistered thereafter, allowing the definition a minimally invasive straight trajectory to the aneurysm neck.

RESULTS

MRA-guided neurosurgery allowed to: 1) direct the approach to the aneurysms at their distal location, 2) to calculate a high spatial accuracy between the target defined and its actual location, 3) reduce the invasiveness of the subarachnoid approach by avoiding unnecessary, proximal to distal, or distal to proximal, dissection/exposure of the main trunks and collateral vessels (lenticulo-striate and callosomarginal branches), 4) tailor the bone opening by optimizing the contours/size of the craniotomy, 5) avoid unnecessary drilling on the midline or opening on parasagittal veins, 6) reduce the duration, strength, and extension of brain retraction. The aneurysms were eradicated successfully without complication.

CONCLUSION

Integration of MRA in the planning and neuronavigation procedure for IA is accurate. It may be applicable routinely and gain popularity, since these images may be handled easily, independently from the navigation equipment. Moreover, it may minimize the morbidity related to the surgical approach. This technique may be especially helpful for selected aneurysms located distally (MCA or pericallosal bifurcations) or very distally (being mycotic by nature and often very difficult to find despite precise localization by preoperative imaging) from the basal cisterns. Additionally, these aneurysmal locations are those for which the optimal choice between surgery and embolization is often difficult. The benefit for the patients with IA should be evaluated in terms of reduction of postoperative neurologic morbidity.

KEY WORDS: Aneurysm, MRA, brain

Poster 90

Multislice CT Angiography in Detection of Cerebral Aneurysms

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PURPOSE

Multislice CT (MSCT) has great potential for use in vascular studies. Our purpose was to determine the accuracy of MSCT angiography in detecting cerebral aneurysms compared to digital subtraction angiography (DSA) or surgery.

MATERIALS & METHODS

One hundred consecutive patients who underwent MSCTA and DSA or surgery were included in the study. MSCTA and DSA results were evaluated independently by different neuroradiologists who performed aneurysm detection, quantitation, and characterization using 2D multiplanar reconstructions, 3D maximum intensity projection, and volume-rendered techniques.

RESULTS

At intraarterial DSA or surgery 113 aneurysms (True + and False -) were detected in 83 out of the 100 patients. A total of 106 aneurysms (True +) were confirmed on DSA/surgery. The sensitivity of detecting aneurysms < 4 mm, 4-10 mm, and >10 mm on a per-aneurysm basis was 0.84 (95 % CI: 0.72, 0.92), 0.97 (95%CI: 0.91, 0.99), and 1.00 (95%CI: 0.88,1.00), respectively. There was moderate agreement between MSCTA and DSA/surgery for aneurysms < 4 mm (k = 0.59), excellent agreement for aneurysms between 4-10 mm (k = 0.81) and for aneurysms larger than 10 mm (k = 1.00). The sensitivity, specificity, and accuracy of MSCTA for detecting aneurysms on a per-patient basis were 0.99 (95% CI:0.96, 1.00), 0.88 (95% CI:0.96,0.99), and 0.98 (95% CI:0.95,1.00), respectively (Table 1).

TABLE 1: Accuracy of MSCT Angiography on a Per-Aneurysm Basis

Size (mm)	Sensitivity	Specificity	PPV	NPV	Accuracy	k Statistics
<4	0.84 (26/31) <u>0.72, 0.92</u>	0.75 (15/20) <u>0.56, 0.88</u>	0.84 <u>0.72, 0.92</u>	0.75, <u>0.56, 0.88</u>	0.8 <u>0.69, 0.91</u>	0.59
4-10	0.97 (58/60) <u>(0.91, 0.99)</u>	0.83 (15/18) <u>0.64, 0.92</u>	0.95 <u>0.90, 0.98</u>	0.88 <u>0.68, 0.97</u>	0.94 <u>0.88, 0.99</u>	0.81
>10	1.00 (22/22) <u>(0.88, 1.00)</u>	1.00 (15/15) <u>0.83, 1.00</u>	1.00 <u>0.88, 1.00</u>	1.00 <u>0.83, 1.00</u>	1.00 <u>0.84, 1.00</u>	1.00

Note.- The numbers in parentheses are the numbers of aneurysms, and the numbers underlined are 95 % Confidence Intervals.

CONCLUSION

MSCTA has a high sensitivity in detecting aneurysms that were confirmed by DSA and/or surgery (used as our gold standards). However, our study suggests that MSCTA may be less sensitive than DSA in detecting < 4 mm size aneurysms.

KEY WORDS: Multislice CT, CT angiography, cerebral aneurysm

Poster 91

Angiographic and MR Imaging Demonstration of Spontaneous Regression of Cerebral Arteriovenous Malformation Due to Thrombosis of Draining Vein

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PURPOSE

Spontaneous regression of cerebral arteriovenous malformation (AVM) is rare and poorly understood phenomenon. We present a case of complete spontaneous occlusion of the AVM associated with thrombosis of the draining cortical vein, demonstrated on MR imaging and digital subtraction angiography (DSA).

MATERIALS & METHODS

A 44-year-old male patient presented with history of two focal seizures 2 months apart involving left leg. Cranial CT showed an ill-defined hyperdense lesion with a few specks of calcification in the right occipital region. Digital subtraction angiography revealed pial AVM in right parieto-occipital lobe with nidus size of 2 cm with multiple feeders from right middle cerebral artery (MCA) and posterior cerebral artery (PCA) (Spetzler grade II). The MCA feeders were tortuous and curving around the convexity to supply the AVM nidus situated in parieto occipital sulcus. The feeding vessels showed dysplastic changes and uneven caliber. A dilated tortuous cortical vein along the parieto-occipital sulcus into the superior sagittal sinus drained the AVM. The patient was put on antiepileptic drugs and was planned for elective embolization at a later date. Three months later preembolization angiogram showed nonfilling of the AVM nidus and draining veins. Contrast was seen in arterial feeders in capillary and early venous phase suggestive of marked slowing of blood flow. MR imaging done on the same day, showed thrombosis of the cortical vein in parieto-occipital sulcus.

RESULTS

Second DSA revealed nonopacification of AVM nidus and slow flow in feeding arteries. Gradient-echo and T1-weighted images demonstrated the thrombosis in draining vein. The patient is neurologically intact and at 6-months follow-up has no recurrence of seizure on antiepileptic drugs.

CONCLUSION

Spontaneous regression or thrombosis of cerebral AVM is a poorly understood phenomenon. The venous thrombosis may be an important factor in spontaneous obliteration of cerebral AVM, which is beautifully demonstrated in the present case.

KEY WORDS: Arteriovenous malformation, thrombosis, spontaneous regression

Poster 92

Perfusion Abnormalities in "Benign" Developmental Venous Anomalies: Are They Really Benign?

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PURPOSE

Developmental venous anomalies (DVAs) are considered benign variants of cerebral venous drainage. We report incidental perfusion abnormalities due to underlying DVAs in three patients undergoing MR imaging workup for symptoms of acute cerebral ischemia.

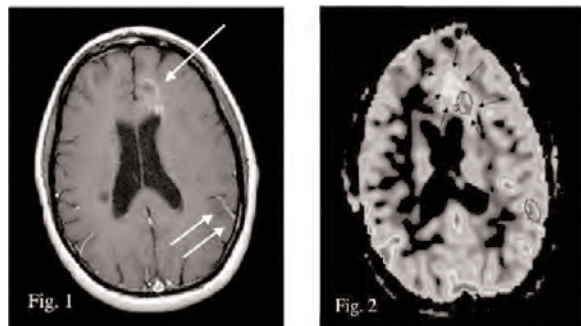
MATERIALS & METHODS

Dynamic susceptibility perfusion MR imaging was performed as part of an acute stroke imaging protocol consisting of rapid T2*-weighted gradient-echo echo-planar imaging during bolus injection of gadolinium-DTPA. Data was transferred to a GE Advantage Windows workstation (software version 4.1) and processed using Functool 2. The following parametric maps were obtained: "negative enhancement integral" (NEI), which is a measure of relative cerebral blood volume, "mean time to enhance" (MTE), which is a measure of the bolus transit time, and "time to minimum" (TTM), which is a measure of the mid-bolus arrival time. Underlying DVAs were identified in three consecutive cases of focal perfusion abnormalities found in the nonsymptomatic hemisphere. Region of interest analysis of perfusion parameters in the tissue around the DVAs and tissue around normal cortical veins was performed to determine the extent of the perfusion changes. Results were expressed as a percentage increase over the normal tissue. Statistical significance was tested using an unpaired Student's t-test. Long TE gradient-echo images were obtained also prior to contrast injection to assess blood oxygen level dependent (BOLD) signal in the tissues around these vessels.

RESULTS

Surrogates of cerebral blood volume and circulation time demonstrated significant increases ($p < 0.005$) in the tissues surrounding the DVAs compared to tissue around normal cortical veins: NEI 12-95%, MTE 8-16%, and TTM 5-23%.

Decreased signal on long TE gradient-echo images was observed in the tissues around DVAs but not normal cortical veins suggesting increased oxygen extraction by the tissue. Figure 1 shows a transmedullary DVA (single arrow) on a gadolinium-enhanced T1-weighted spin-echo. The double arrow shows a normal cortical vein. Figure 2 shows the corresponding blood volume map (NEI) with ROI #1 on tissues surrounding the DVA, and ROI #2 on tissues surrounding the normal cortical vein. Black arrows show the extent of the relative cerebral blood volume increase around the DVA.



CONCLUSION

Our findings indicate the presence of perfusion abnormalities around DVAs that could put local tissue at metabolic risk from venous congestion, i.e., “misery” venous drainage.

KEY WORDS: Developmental venous anomaly, MR perfusion, BOLD

Poster 93

Emergent Neuroimaging for Headaches during Pregnancy

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PURPOSE

Headache is a common neurologic complaint during pregnancy. Although the majority of cases are unrelated to intracranial pathology, such headaches may herald ominous diagnoses including eclampsia, stroke, tumor, subarachnoid hemorrhage, or cerebral venous thrombosis. Emergent evaluation of the pregnant headache patient requires rational selection of acute neuroimaging studies, yet guidelines do not exist. We investigated the demographic factors and clinical features of pregnant women with headaches presenting to an emergency room that are predictive of intracranial pathology on acute neuroimaging studies.

MATERIALS & METHODS

Retrospective review of demographic factors, clinical features, and radiologic findings was conducted in a consecutive case series of 63 pregnant women (median age 25 years, range 15-41 years) emergently evaluated with a chief complaint of headache. Clinical data were abstracted from emergency room medical records, hospital course, and discharge summaries. Clinical variables included prior pregnancy and medical histories, presenting factors, gestational age, neurologic symptoms, headache features, examination findings, and laboratory investigations. Radiologic variables included

the use of various imaging modalities, time delay to imaging, and neuroimaging findings. Multivariate logistic regression analysis examined predictors of intracranial pathology on emergent neuroimaging studies.

RESULTS

Multiparous, African-American women constituted a majority of the cases, presenting with a severe headache at various timepoints throughout pregnancy (median gestational age 25 weeks, range 6-40 weeks). Headaches generally persisted for more than several hours (median duration 48 hours) and were frequently accompanied by photophobia (59%), nausea (52%), vomiting (37%), phonophobia (23%), and occasionally with fever (11%), meningismus (9%), or seizures (7%). Headaches were described frequently as dull or throbbing (77%), bilateral (65%), and predominantly frontal (64%). A neurology consult was obtained in 67% of cases, with neurologic examination findings in 43%. Emergent neuroimaging included noncontrast head CT in 86%, MR imaging in 60%, and MR venography in 40%. CT and MR imaging were acquired in 46% of cases, whereas only CT was performed in 40% and only MR imaging in 14%. Emergent neuroimaging studies revealed an underlying headache etiology in 26%, although sinusitis accounted for 8%. Intracranial pathology included cerebral venous thrombosis in 6%, reversible posterior leukoencephalopathy/eclampsia in 6%, pseudotumor in 3%, and intracranial hemorrhage in 3%. There were no demographic or clinical variables that were predictive of intracranial pathology on emergent neuroimaging studies.

CONCLUSION

Emergent neuroimaging studies may reveal an underlying headache etiology in 26% of pregnant women. The diagnosis may be established on CT alone in a subset of cases. Despite the frequent occurrence of concerning symptoms and examination findings, no clinical features are predictive of pathology on acute neuroimaging studies.

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KEY WORDS: Pregnancy, headache

Head and Neck 94-108

Poster 94

A Pictorial Review of the Anatomy and Common Pathology of the Buccal Space: "The Overlooked Space"

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PURPOSE

To familiarize the reader with the detailed, important anatomy of the buccal space including its relationship to surrounding structures and to illustrate a variety of pathology that can occur including benign, malignant, vascular, and infectious processes.

MATERIALS & METHODS

We retrospectively reviewed a large series of cases from a tertiary hospital demonstrating the CT, MR imaging, and sialographic manifestations of buccal space masses. Anatomical drawings were used to illustrate the buccal space and related structures.

RESULTS

A variety of pathology involving the buccal space will be demonstrated including, but not limited to, ectopic salivary gland tumors, diseases related to the main parotid salivary gland duct, hemangioma of infancy, lymphangioma, venous developmental anomalies, rhabdomyosarcoma, lymphoma, lipoma, neurofibroma, primary and metastatic tumors from neighboring structures, and infectious processes.

CONCLUSION

The buccal space often receives less attention than the other spaces of the head and neck due to its small size and predominantly fatty composition. However, because of the close relationship to important structures both in and around this space, a variety of pathology may be seen. These structures include the parotid gland, masticator space, minor salivary glands, lymph nodes, muscle, sinuses, facial artery and vein, and other neurovascular structures. We hope that this review will enhance the readers knowledge of the anatomy and pathology of this often overlooked space, thereby facilitating diagnosis of lesions therein.

KEY WORDS: Buccal space, anatomy

Poster 95

Cervical Fasciae and Spaces Justified by Modern Imaging Modalities

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PURPOSE

To examine the accuracy of the documented cervical fasciae and spaces by modern CT and MR images.

MATERIALS & METHODS

Enrolled are forty cases with the spectrum of head and neck diseases from the indolent one as thyroid goiter, postradiation change to the relentless neck infection collected for studying the disease spread pathway and corroborated with the prior anatomical work done as early as 1938 by Grodinsky M. and Holyoke E.

RESULTS

1. Retropharyngeal space can freely communicate with pretracheal space only at the hypopharynx level, whereas the rest of these two spaces are independent as justified by the spreading route of cranially and/or caudally directing huge thyroid goiter. 2. The lateral boundary of suprahyoid retropharyngeal space, that is, cloison sagittale, is dehiscence or weak in most cases of postradiation neck and neck infection, allowing either sterile or infectious fluid collection, contiguous with that in parapharyngeal space. 3. Parapharyngeal and retropharyngeal spaces are more readily for extension of neck infection toward mediastinum, rather than the proposed "danger space."

CONCLUSION

By observing the disease spreading routes on imaging study, the concept of cervical fasciae and spaces can be more rationalized.

KEY WORDS: Fascia, neck

Poster 96

MR Findings of Angiosarcoma of the Scalp

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PURPOSE

Angiosarcoma of the scalp is a rare disease. There have been many published papers regarding pulmonary metastases from angiosarcoma of the scalp; however imaging findings of angiosarcoma of the scalp have not been reported yet. The purpose of our study was to investigate the MR findings of angiosarcoma of the scalp retrospectively.

MATERIALS & METHODS

There were 11 patients (7 male and 4 female, 70 years old on average, ranging from 51 to 90 years old) diagnosed as having angiosarcoma of the scalp by biopsy or operation from 1996 to 2003 in our institute. Ten out of 11 patients, whose MR images or reading reports were available, were included

in our study. All patients were examined with 1.5 T MR units and commercially available head coils. T1-weighted imaging was carried out for all patients. Eight patients underwent enhanced study and 4 of them had fat saturation technique. T2-weighted imaging was performed for 8 patients and 4 of them had fat saturation technique. Both MR images and reading reports were available for 8 patients and only reading reports were available for the other 2 patients. We retrospectively evaluated MR findings of angiosarcoma of the scalp.

RESULTS

MR images revealed that all angiosarcoma of the scalp had thickened scalps or tumors. Most tumors had prolonged T1 and T2 relaxation times and they were well-enhanced. Seven patients had thickened galea aponeurotica and occipitofrontal muscles with abnormal signal intensities. T1-weighted images demonstrated that thickened subcutaneous fat had comb-like or reticular hypointense patterns. T1-weighted images showed skull invasion as hypointense tumors in two patients. Extents of the skull invasion were well demonstrated on contrast-enhanced T1-weighted images with fat saturation. T2-weighted MR imaging with fat saturation, which was performed for 4 patients, demonstrated tumors as being larger than T1-weighted imaging. Contrast-enhanced T1-weighted imaging with fat saturation, which was carried out for 4 patients, more clearly showed tumors invading into subcutaneous fat tissue and muscles than other imaging techniques. However contrast-enhanced T1-weighted imaging without fat saturation, which was done for the other 4 patients, did not clearly reveal borders between tumors and subcutaneous fat. At least two slice orientations were required for better delineation of the tumors. We were able to compare inspection findings and MR findings of angiosarcoma of the scalp for 7 patients. Five patients showed the tumors were larger on MR images than on the inspections, due to the fact that we cannot see the invading tumor by inspection if it has spread into the surrounding subcutaneous fat tissue and subcutaneous muscles. The remaining 2 patients demonstrated the findings were almost the same.

CONCLUSION

Contrast-enhanced T1-weighted images with fat saturation technique and T2-weighted images with fat saturation technique demonstrated angiosarcoma of the scalp very clearly. MR imaging was useful in demonstrating the extent of angiosarcoma of the scalp because it demonstrated tumors that had invaded into the surrounding structures more clearly than inspections.

KEY WORDS: Angiosarcoma, scalp, MR imaging

Poster 97

CT and MR Findings of Primary Facial T-Cell Lymphoma

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PURPOSE

To describe the radiologic findings of primary facial T-cell lymphoma.

MATERIALS & METHODS

CT and MR imaging findings of seven consecutive patients with pathologically proven facial T-cell lymphoma were evaluated retrospectively. Patients with T-cell lymphoma involving sinonasal cavity or lymph nodes were excluded, those who were included consisted of extranodal NK/T-cell and peripheral T-cell in four and three patients, respectively.

RESULTS

Infiltration and swelling of the superficial space of the face were noted on both CT and MR imaging, mimicking inflammation or infection. Also seen were well enhancing, either small nodular (n = 5) or infiltrative mass-like lesions (n = 2) within the areas of infiltration, which showed intermediate signal intensity on T2-weighted images.

CONCLUSION

Primary facial T-cell lymphoma is a rarely encountered tumor and demonstrates infiltration and swelling, mimicking inflammation or infection. Nodular or infiltrative mass-like lesions may be helpful for its diagnosis.

KEY WORDS: Lymphoma, T-cell

Poster 98

Sequential Angiographic Changes in Carotid Arteries after PTA/Stenting

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PURPOSE

Recently, the results of PTA/stenting for the internal carotid arteries are improving rapidly after the introduction of various types of protective devices. However, the sequential angiographic changes after stenting for the carotid stenosis are still unknown. We investigated sequential angiographic changes after self-expanding stent deployment for internal carotid arteries.

MATERIALS & METHODS

One hundred eighty-six cases with 200 lesions treated with PTA/stenting for internal carotid stenosis were analyzed. Patient's age was varied from 53 years old to 82 years old (mean 71.3 years old). Male/female ratio was 174/26. Ninety percent of the cases were treated using distal protection

devices and self-expanding stents (SMART, Acculinc, Wallstent) were deployed. We examined morphologic changes of stent-treated carotid arteries before, immediately after, and 6 months after stenting using angiogram and ultrasound.

RESULTS

Average stenotic ratio improved from 77.1% to 7.3% after stenting. Average stenotic ratio after 6 months was 18.2%. Five cases were treated repeatedly for restenosis with PTA. Restenosis improved after PTA, but one case resulted in asymptomatic total occlusion. The cases with distal kink after stenting tended to improve on angiogram 6 months after stenting. The ulcerative lesions disappeared in all cases 6 months after stenting.

CONCLUSION

Restenosis greater than 70% appeared 6 months after stenting in three cases. The distal kink or ulceration tended to improve on follow-up angiogram after stenting.

KEY WORDS: Carotid artery, stent, angiography

Poster 99

Algorithmic Approach to Imaging Diagnosis of Neoplastic Lesions of the Jaw

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PURPOSE

The purpose of this communication is to present a practical approach to the diagnosis of neoplastic lesions occurring within the mandible and maxilla in association with dentition. A systematic, algorithmic approach based on appearance, morphology, and evolution will be presented to facilitate a clearer understanding and improve the accuracy of the pathologic diagnosis by the evaluator. CT, MR imaging and conventional radiography will be used to illustrate the spectrum of neoplastic pathology in this anatomical region.

MATERIALS & METHODS

Patients records with neoplastic pathologies of the mandible and maxilla over the past 20 years were reviewed. Specific neoplastic pathologic entities which best illustrate the characteristics to be highlighted were chosen.

RESULTS

This algorithmic approach for the evaluation of neoplastic entities of the mandible and maxilla facilitates and significantly improves the evaluators approach to neoplastic pathologic entities in this area.

CONCLUSION

It is intended that the use of the above algorithm will afford all radiologists the ability to confidently evaluate neoplastic pathologies in this area.

KEY WORDS: Neoplasm, mandible, maxilla

Poster 100

Ocular Lesions: A Neuroimaging Spectrum

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PURPOSE

To demonstrate the utility of CT and MR imaging in the identification and characterization of ocular diseases and disorders.

MATERIALS & METHODS

CT and MR images of 30 patients with ocular lesions were reviewed.

RESULTS

A wide variety of ocular diseases and disorders were demonstrated with CT and MR imaging including retinoblastoma and other primary neoplasms of the eye, metastatic lesions of the globe, retinal and choroidal detachments, traumatic conditions of the eye including rupture of the globe, colobomas, retinopathy of prematurity, pseudotumor cerebri, drusen bodies, and persistent hyperplastic primary vitreous.

CONCLUSION

CT and MR imaging can be valuable in the diagnosis and management of ocular diseases and disorders. Neuroimaging helped diagnose and guided treatment in many conditions of the eye. The imaging characteristics of each lesion will help the reader to better understand these conditions and thus facilitate the differential diagnosis.

KEY WORDS: Ocular lesions

Poster 101

Head and Neck Lesions in the Immunocompromised Host

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Immunosuppressed patients (e.g., HIV-infected individuals, diabetes mellitus, transplant recipients, patients treated with immunosuppressive drugs), frequently present head and neck lesions. The involved organs are the salivary glands, the temporal bone, the pharyngolaryngeal mucosa and the nodes. Granulations tissues, perivascular inflammation, and neoplasms may be encountered. Our purpose is: 1. to illustrate by correlation imaging-clinical cases the main lesions encountered; 2. to demonstrate imaging features and anatomicopathologic correlations of Kaposi sarcoma, the pathogeny of which involves a complex interaction of angiogenic growth factor; 3. to demonstrate posttransplantation lymphoproliferative disorder which may mimic lymphoma; 4. To show complications of these lesions which may inaugurate the disease such as Lemiere syndrome, invasive fungal sinusitis, skull base osteomyelitis

KEY WORDS: AIDS, immunocompromised host, posttransplantation disorder

Poster 102**Endovascular Treatment of Persistent Epistaxis Due to Pseudoaneurysm Formation of Ophthalmic Artery Secondary to Nasogastric Tube Removal**

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PURPOSE

Persistent epistaxis due to pseudoaneurysm formation during nasogastric tube insertion or removal is very rare. Anterior and posterior nasal tamponade, and cauterization are frequent initial interventions. Angiography and endovascular treatment had been preferred to surgical intervention for the detection of the origin and management of persistent epistaxis recently. We present a 60-year-old man with persistent epistaxis secondary nasogastric tube removal. A pseudoaneurysm formation which was developed from anterior ethmoidal branches of right ophthalmic artery was observed and endovascular treatment performed successfully.

MATERIALS & METHODS

Sixty-year-old man was admitted to our hospital because of persistent epistaxis for 20 days which has started during nasogastric tube removal that was placed for an abdominal operation. The patient had anterior and posterior nasal tamponades, cauterization, and multiple blood transfusions in that period repeatedly at outside hospitals. The patient was taken for angiography. The vessels were cannulated via the right femoral artery and selective angiographic studies of the fascial and internal maxillary artery were analyzed. Although there was no pathologic finding at specific injections, embolization with PVA particles was performed. Following this, anterior tamponades were removed. The patient did not continue to bleed. The procedure was stopped and he was taken to observation room. One hour later the patient developed massive epistaxis again requiring 5 units of packed red blood cell and 3 units of fresh-frozen plasma. He was immediately taken back for angiography.

RESULTS

There was no pathologic finding at specific fascial and internal maxillary artery injections. An injury to the ethmoidal branch of ophthalmic arteries or other arterial origins of bleeding was suspected. The ICA angiography revealed a pseudoaneurysm of an anterior ethmoidal branch of right ophthalmic artery, which was approximately 3-4 mm of diameter. The catheter was advanced to these ethmoidal branches through ophthalmic artery and the pseudoaneurysm was occluded with NBCA-histoacryl injection. The epistaxis was stopped suddenly. The patient was observed for two days. There was no recurrent epistaxis during this time and on 1-month follow-up.

CONCLUSION

Pseudoaneurysm formation and persistent epistaxis during nasogastric tube insertion is very rare. Angiography and endovascular treatment can be life saving in cases of the origin of bleeding cannot be found or the conventional methods are impaired to stop bleeding. For this purpose the secondary branches of nasal blood supply like ophthalmic artery should be observed as well as internal maxillary and fascial artery on angiography.

KEY WORDS: Nasogastric tube, pseudoaneurysm, endovascular treatment

Poster 103**Apparent Diffusion Coefficients in the Evaluation of Sinonasal Inflammatory Disease**

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PURPOSE

The sinonasal secretions in sinonasal inflammatory disease represent the physiologic spectrum of mucous (primarily watery, serous, thick, and desiccated mucous or even a stone-like mucous plug). It has been demonstrated previously that changing T2-weighted signal intensity from high to low signal, or even a signal void, reflects these mucous states. The protein concentration, the amount of free water, and the viscosity in the secretions vary, leading to differences of molecular motion. We, therefore, hypothesized that apparent diffusion coefficients (ADCs) can be used to differentiate the state of the sinonasal secretions. The purpose of our study is to test this hypothesis.

MATERIALS & METHODS

We retrospectively reviewed MR images of 23 patients with sinonasal inflammatory diseases. Abnormal sinonasal secretions were found in 33 sinuses (13 in maxillary, 10 in sphenoid, 5 in frontal, and 5 in the ethmoid sinuses). MR studies including both conventional and diffusion-weighted imaging ($b = 1000$) were performed using a 1.5 T unit. Based on the T2-weighted signal intensity, the 33 sinuses involved by inflammatory diseases were divided into 2 groups based on T2-weighted images: 24 sinuses with high signal secretions and 9 sinuses with iso ~ low signal secretions. The ADCs were measured and regions of interest were placed over the sinonasal secretions. The difference of the ADCs between the two groups was analyzed statistically by using a t-test.

RESULTS

The ADCs in the sinonasal secretions with high signal intensity on T2-weighted images ranged from 11.8 to 29.1 (mean $\pm$ SD, 20.49 ± 6.19) $\times 10^{-4}$ mm²/s. By contrast, in the sinonasal secretions with iso ~ low signal intensity on T2-weighted images, the ADCs ranged from 2.78 to 17.1 (mean $\pm$ SD, 10.26 ± 5.98) $\times 10^{-4}$ mm²/s. Despite the presence of overlap of the ADC values between these 2 groups, the former was significantly higher than the latter ($P < 0.001$).

CONCLUSION

This study revealed that when the T2-weighted signal intensity goes from high to iso/low the ADCs of sinonasal secretions become significantly restricted. This suggests a correlation between the ADCs and components of the sinonasal secretions. Diffusion-weighted imaging may provide quantitative information useful to the diagnosis of sinonasal inflammatory disease.

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KEY WORDS: Sinonasal inflammatory disease, apparent diffusion coefficients, diffusion-weighted imaging

Poster 104

How to Distinguish the Glossopharyngeal Nerve from the Vagus and Accessory Nerve Complex in the Region of Jugular Foramen: A Comparative Radioanatomical Study

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PURPOSE

To distinguish the glossopharyngeal (IX) nerve to the vagus (X) and accessory (XI) nerve complex in the region of jugular foramen (JF) by multislice CT and MR imaging.

MATERIALS & METHODS

Ten formalin-preserved adult cadavers were scanned by multislice CT (General Electric lightspeed Qx/i) and 1.5 T MR scanner (Marconi, Eclipse) prior to dissection. Five cadavers were dissected into 1.0 mm celloidin contiguous sections in axial and coronal plane.

RESULTS

The rootlets of the IX nerve emerge from the postolivary sulcus. The nerve enters the JF through the uppermost porus (pars nervosa). When it enters the JF, the nerve is wrapped by a connective tissue septum, which is defined as the glossopharyngeal meatus and just beneath the out opening of the cochlear aqueduct. In the lower section (mean 2.0 mm, with a range from 0.9 mm to 3.3 mm), the X and XI nerve complex passes the JF through the vagal meatus. In all ten specimens, the vagal meatus obviously are wider and shorter than the glossopharyngeal meatus. Two complete and four incomplete bony canals were found in all specimens, 10% and 20% separately. Both of the meatus can be well recognized by CT scan. So, these nerves can be distinguished from each other by MR imaging. From the anterior to the posterior, the structures within the JF range as follows: the IX nerve, the inferior petrosal sinus, the X and XI nerves, the posterior meningeal artery and the jugular bulb. When they exit the jugular foramen, all of these nerves are located medial to the internal jugular vein. The IX nerve lies at the upper and deeper portion. The X and XI nerve complex is more superficial than the IX nerve.

CONCLUSION

With the help of the anatomical landmarks of these nerves, we could distinguish them by CT and MR imaging.

KEY WORDS: Anatomy, CT, MR imaging

Poster 105

So-called Huschke's Foramen or Foramen Tympanicum: Anatomical and Pathologic Significance

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PURPOSE

Huschke's foramen is an infrequent anatomical variation located on the tympanic bone connecting the external auditory canal with the temporomandibular joint. Occasionally pathologic cases are reported in the literature. The purpose of the study is to define its precise location, its prevalence on high resolution CT, and its pathologic correlation.

MATERIALS & METHODS

One hundred consecutive high resolution CTs of the temporal bone (200 ears) have been studied prospectively (Philips). High resolution CT was performed using the following parameters: 120 KV, 400 MAS, high resolution filters, matrix of 728 x 728. Axial, sagittal, and coronal reformed images were acquired using slice of 0.6 mm. Patients with previous history of ear surgery or less than 5 years old have been excluded from the study. For all the patients the following items were appreciated: existence of the foramen, its size, its shape, and its location in regards to the tympanic membrane. Patients with reduction of thickness of the tympanic bone (inferior to 1 mm) were numbered separately.

RESULTS

Huschke's foramen was found in 15% of the ears with mean diameter of 2 mm. Reduction of thickness was found in 30% of the ears. Other cases of reduction of thickness are discussed (Santorini's canal, petrotympanic suture). Two cases with salivary herniation into the external auditory canal causing otosialhorea and temporomandibular joint herniation are reported.

CONCLUSION

High resolution CT identifies with great ease Huschke's foramen due to MPR and to thickness. Its knowledge is useful especially for otology, otosialhorea, and temporomandibular joint pathology.

KEY WORDS: Tympanic, Huschke

Poster 106**Otalgia: Algorithm of Imaging Studies**

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Otalgia with a normal tympanic membrane is a frequent symptom causing a very difficult task for its imaging evaluation. Our purpose is: 1. to illustrate the anatomical patterns of the nervous ways causing ear pain, e.g., V3, VII, IX, X cranial nerves; 2. to identify the main ear, nose, throat (ENT) sites to check in imaging study; 3. to propose the best imaging protocol for imaging procedure; 4. to illustrate this algorithm by 10 cases of clinical imaging correlations

KEY WORDS: Ear, pharynx, otalgia

Poster 107**Value of 3D T2-Weighted MR Imaging for Screening in Asymmetric Sensory Neural Hearing Loss in Older Population Prior to Hearing Aids**

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PURPOSE

Laboratory testing and MR imaging commonly are used to delineate retro-cochlear pathology in asymmetric sensorineural hearing loss (ASNHL). The aim of this study is to determine the use of 3D T2-weighted MR imaging in diagnostic evaluation of ASNHL in older patients as a screening procedure prior to hearing aids.

MATERIALS & METHODS

Retrospective analysis of 200 consecutively investigated patients (males, mean age 56 years) from Veteran hospital between 2001-2003. Results of audiogram, auditory brainstem evoked response (ABER) and MR imaging was reviewed with clinical findings. MR imaging included T1, T2 (FSE fast spin-echo) in axial and coronal plane and 3D T2 volumetric imaging with multiplanar reconstruction. Additional axial and coronal T1-weighted images after intravenous gadolinium injection also was obtained. The examination concluded in average 40 minutes.

RESULTS

Most of the patients had asymmetrical hearing loss in high frequency range. Auditory brainstem evoked response (n = 36) was equivocal in 90%. Auditory brainstem evoked response was definitely abnormal in 3 patients only. Vestibular schwannoma was found only in 4 patients on MR imaging. Other findings that could be related to ASNHL were dehiscent jugular bulb in one, vascular loop near root entry zone in ten, pontine infarct in two, cerebellar infarction five, and mastoiditis in seven patients. Incidental finding of loss of flow signal was seen in internal carotid arteries of three patients. In this particular age group the yield of MR imaging to detect retro-cochlear pathology is low. On analy-

sis of individual sequences T2-weighted 3D volume imaging with reconstructions detected 95% of the findings and had excellent anatomical demonstration of the nerves.

CONCLUSION

Detailed analysis of the above data suggests that prior to MR imaging patients are divided into low and high probability for retro-cochlear pathology. In low probability group such as older patients with ASNHL being screened for hearing aids, a T2 3D volumetric imaging is adequate in excluding retro-cochlear pathology. In high probability group detailed evaluation including postcontrast studies should be obtained.

KEY WORDS: Hearing loss, sensorineural deafness, MR imaging

Poster 108**Papillary Endolymphatic Sac Tumors: Imaging Findings with Histopathologic Correlation in 5 Cases**

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PURPOSE

To determine the CT, MR imaging, angiographic appearance, clinical and histopathologic finding of papillary endolymphatic sac tumors (PELSTs).

MATERIALS & METHODS

Clinical, imaging, and histopathologic studies in 5 patients with papillary endolymphatic sac tumors were reviewed retrospectively. There were 4 male patients and one female. Average age 26.8 years (range, 12-41 years). Clinical symptoms such as hearing loss, tinnitus, facial palsy, and vertigo presented. The time range between the initial onset of symptoms and surgical resection was 4 to 9 years. Four of the five patients also underwent angiograms. CT scans were evaluated for bone erosion and calcification. MR images, for signal intensity, enhanced patterns and flow voids, and angiograms, for tumoral blood supply.

RESULTS

All tumors were destructive, contained calcifications centered in the retrolabyrinthine region and showed irregular bone margins at CT. MR imaging appearance varied with lesion size and nature. Three of the five tumors showed a high-signal-intensity margin at unenhanced T1-, T2-weighting, and the margins were more clear with fat-suppress imaging. The others were heterogeneous and contained cystic high-signal-intensity area with T1- and T2-weighting. Regions where endolymphatic sac were anatomically in all tumors showed irregular low-signal-intensity region. All tumors had flow voids. The blood supply arose predominantly from the external carotid artery. Two tumors had additional supply from posterior circulation. At histopathologic findings, PELSTs were shown to consist of complex, interdigitating papillary processes that infiltrate the surrounding connective tissue and bone. These papillations typically were embedded in sheets of dense fibrous tissue with evidence of recent and previous hemorrhage, and lined with a single layer of cuboidal epithelial cells.

CONCLUSION

Papillary endolymphatic sac tumors are destructive, hyper-vascular lesions that arise from the temporal bone retro-labyrinthine region and may be confused histopathologically with other common lesions. Combining these imaging findings with original location of lesions may be more helpful to distinguish these lesions from other more common, aggressive temporal bone tumors, and improve histopathologic diagnosis.

KEY WORDS: Papillary endolymphatic sac tumors, retro-labyrinthine region, imaging findings

**Interventional
109-148**

Poster 109

Giant and Large Aneurysms of the Intracranial Distal Arteries Treated by Endovascular Occlusion of the Parent Artery: Long-Term Clinical and Radiologic Follow-Up

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PURPOSE

To evaluate long-term clinical and radiologic follow-up in patients with large or giant aneurysms of distal intracranial arteries treated by endovascular occlusion of the distal parent artery.

MATERIALS & METHODS

Retrospective study was carried out in nine patients (four men and five women ranging in age from 18 to 64 years, mean age 42 years) with a distal giant or large aneurysm treated by endovascular occlusion of the parent artery. Only patients with at least 1 year follow-up after treatment were included in the study. Eight lesions were supratentorial and distal to circle of Willis and one aneurysm was infratentorial. All four giant aneurysms were partially thrombosed (one aneurysm of the superior branch of the middle cerebral artery bifurcation, one aneurysm of the left pericallosal artery, and two aneurysms of the P2-P3 segments of the posterior cerebral artery) and four of five large aneurysms were fusiform (three aneurysms of a distal cortical branch of the middle cerebral artery, one aneurysm of the pericallosal artery, and another lesion located distally on the postero-inferior cerebellar artery. An occlusion test of the parent artery with a small balloon was performed in 3 cases in order to evaluate the clinical and angiographic tolerance to the occlusion. After careful analysis of the leptomeningeal collaterals, the occlusion of the parent artery was performed using coils in seven cases and glue in two. CT and/or MR studies were available in all patients. Clinical and imaging follow-up was performed from 1.5 to 7 years (mean: 4.5 years) after treatment.

RESULTS

A complete and persistent exclusion of the aneurysm was obtained in all cases. No complications were observed except for one patient, with a posterior cerebral artery giant aneurysm, who presented transient parestheses and mild oculomotor paresis which completely regressed in 1 week. In the patients with giant partially thrombosed aneurysms, CT and MR follow-up studies showed an important shrinkage of the aneurysmal thrombosed compartment and disappearance of the mass effect.

CONCLUSION

In some anatomical configuration, endovascular occlusion of the parent artery appears a safe and efficacious technique in the treatment of giant and large aneurysms of the intracranial distal arteries. Follow-up studies confirm exclusion of the aneurysm and good clinical tolerance to the occlusion.

KEY WORDS: Aneurysm, intracranial, embolization

Poster 110

HIV-Associated Intracranial Aneurysms: Endovascular Treatment

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PURPOSE

HIV-associated intracranial aneurysms have been reported rarely in the literature. However, there is no report of endovascular treatment in these patients. We present a case with HIV-induced intracranial aneurysms that was treated by endovascular embolization.

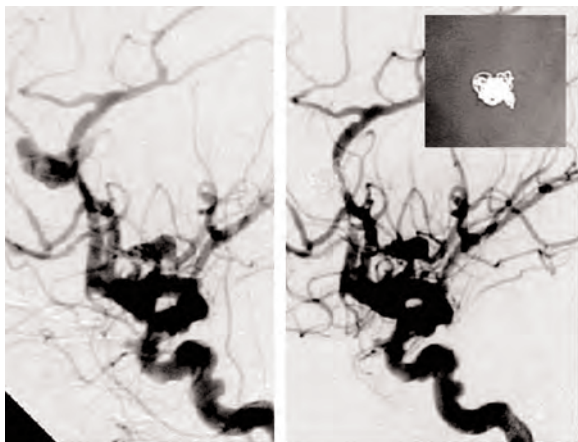
MATERIALS & METHODS

Retrospective review of a case with HIV-associated multiple intracranial aneurysms was performed including result of endovascular embolization of one of the aneurysms. The clinical and radiologic details including the follow-up imaging were studied.

RESULTS

A 14-year-old boy presented with sudden onset severe headache. Patient was detected to be HIV positive at age of 5 years; however, he did not have any symptoms related to the disease. His mother was also HIV positive, indicating antenatal transmission. CT and MR imaging revealed sub-arachnoid hemorrhage in the interhemispheric fissure in frontal region along with multiple aneurysms with vessel wall calcification. Digital subtraction angiography (DSA) showed multiple broad-based and fusiform aneurysms involving B/L ICA, B/L MCA, B/L PCA and basilar artery along with a right distal ACA fusiform aneurysm. His HIV viral load was found to be high (40255 copy/ml). Endovascular embolization of the right ACA aneurysm along with the parent artery occlusion was performed with detachable coils. Presence of leptomeningeal collateral to right ACA cortical branches was seen and the procedure was uneventful. Patient was started on antiretroviral therapy. He had an episode of right hemiparesis 4 months after the procedure, with complete recovery in 1 week. Imaging revealed

left basal ganglia infarct. At 1-year follow-up, CT angiogram showed persistent occlusion of the embolized aneurysm with no apparent change in rest of the aneurysms. CT and MR imaging also did not show any new intracerebral lesions. His viral load also had come down to < 20 copy/ml.



CONCLUSION

HIV virus infection rarely may be associated with intracranial aneurysms. Endovascular treatment may be feasible in these cases. In contrast to the reported literature, our patient has had a good clinical outcome with probable stabilization of the aneurysms on retroviral therapy.

KEY WORDS: HIV vasculopathy, aneurysm, coiling

Poster 111

Surgical Aneurysm Model in Swine: An Histologic and Molecular Analyses of the Natural History of Thrombosis and Healing

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PURPOSE

The surgical model for carotid aneurysms in swine is used widely for reproducing the gross morphology of saccular aneurysms for experimental study. The aim of this investigation was to describe the cytokine expression profile and histology of this model during its natural course of thrombosis and healing.

MATERIALS & METHODS

Forty-two lateral carotid aneurysms were created in 21 Yorkshire-cross swine. Aneurysms were created with a small, 3 mm ostium in order to encourage thrombosis. Thrombosis was confirmed angiographically before closure. Swine were sacrificed at seven time points: immediately, 1 day, 3 days, 7 days, 14 days, 30 days, and 90 days postoperatively. Three swine were sacrificed at each time point. In each swine, one aneurysm was used for histopathology and

the other for RNA harvesting and potential molecular analysis. Cytokine expression analysis was performed on the 7-, 14-, and 30-day postop specimens. cDNA was reverse-transcribed from the harvested RNA and hybridized to a commercially available, nylon-based array spotted with cDNA of 96 common human cytokines. Data were analyzed with the Significance Analysis of Microarrays program (SAM version 1.13, Stanford University).

RESULTS

Presacrificial angiograms confirmed aneurysm occlusion and parent carotid artery patency in all animals. Histologic examination demonstrated marginal thrombus organization, granulation tissue formation, and cellular infiltration as early as 3 days postoperatively. At 7 and 14 days postoperatively, most thrombotic products had been replaced by granulation tissue and myofibroblasts. By 30 days postop, the aneurysm lumen was shrunken and replaced by fibroblasts and collagen. By 90 days, the shrunken aneurysms were replaced completely by collagenous scar. Statistical analysis of the cytokine-focused cDNA array showed significantly increased expression of 33 different cytokines. Thirty cytokines were elevated significantly above time zero levels at 7 days postop (q-value = 0.174%), 20 cytokines were up-regulated at 14 days postop (q-value = 0.094%), and 26 cytokines up-regulated at 30 days postop (q value = 1.202%). The degree of overall up-regulation was highest at 7 days postop, with SAM scores ranging from 5.4-12.9, as opposed to 0.5-0.7 at day 14, and 0.6-1.1 at day 30. Seven cytokines were up-regulated significantly only at day 7, including IL-22, PDGF a, PDGF b, TGF b-3, and VEGF-B. TGF-a was the single most up-regulated of these genes, with a SAM score of 12.9. Sixteen cytokines were up-regulated at days 7, 14, and 30, including IL-11, TGF b-1, and FGF homologues. FGF-11 was elevated only at day 30.

CONCLUSION

This investigation is one of the most detailed descriptive studies to date of an important animal model for aneurysms. The results indicate that a multiple but selected repertoire of pro and antiinflammatory cytokines may be involved in the pathophysiology of aneurysm healing, aneurysm growth, and endovascular treatment. The consistent cytokine gene expression profile associated with histologic thrombosis and healing sequence strongly validate the usefulness of the swine model for carotid aneurysms and will serve as a baseline for comparison to findings in aneurysms treated with various experimental materials under development at our institution.

KEY WORDS: Aneurysm, model, cytokine

Poster 112**Elastase-Induced Saccular Aneurysms in Rabbits: Instructions “for the Rest of Us”**

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PURPOSE

Although the creation of elastase-induced saccular aneurysms can be quick and easy, for many who have followed instructions from existing publications and word-of-mouth it has been a nerve-racking struggle with poor outcomes. Details on the survival rate of rabbits and the aneurysms' neck-to-dome ratio have yet to be published - until now. We hereby detail some finer points of creating elastase-induced saccular aneurysms in rabbits, making this model easier to reproduce by the entire research community.

MATERIALS & METHODS

We created over 100 elastase-induced saccular aneurysms in rabbits during the past 2 years. Health, surgical, and autopsy records of all animals were saved. We recorded all digital runs and saved them in DICOM format, also recorded fluoroscopic images during procedures to S-VHS tape in most of the elastase treatment and follow-up sessions. This way we built a large database of our successful cases and failures. Retrospective data analysis was performed on a regular basis for quality control, in order to improve our outcome. As new pitfalls were pointed out, preventive measures were established by changing our protocol. Beyond our quality control findings we also will provide instructions on how to evaluate contrast washout, a reliable immediate predictor of successful treatment.

RESULTS

Our initial outcome was below 40%, but improved to 96% as we eliminated most of the pitfalls. Our difficulties were related to the following issues: poor quality rabbit supplier, poor infection prophylaxis, improper anesthesia and recovery procedures, improper catheters, effect of catheter and balloon position on outcome, effect of elastase quality and quantity on outcome, and effect of elastase injection method and rate on outcome.

CONCLUSION

We believe that elastase-induced aneurysms in rabbits have features that make them a better model for certain applications than the surgical model created in dogs or pigs. It is important to make the method reproducible, thus widely available to all interested researchers.

KEY WORDS: Elastase, aneurysm, rabbit

Poster 113**Utility of Three-Dimensional Angiography in the Treatment of Cerebral Aneurysms**

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PURPOSE

Although pretreatment planning in the management of cerebral aneurysms has traditionally been based upon two-dimensional angiography (2DA), rotational three-dimensional angiography (3DA) allows for a more accurate assessment of both aneurysm and parent-vessel characteristics. Various institutions have reported on the clinical applications of this technique, but only a limited number of studies actually have quantified the benefits (1, 2). This study attempts to more clearly define the diagnostic utility of 3DA in comparison with 2DA for the management of both ruptured and unruptured cerebral aneurysms.

MATERIALS & METHODS

Angiograms from all patients with cerebral aneurysm presenting to our institution between June 2002 and January 2003 were analyzed retrospectively. All angiograms were reviewed by both a neurosurgeon and neurointerventionalist. The 2DA and 3DA data were stratified as providing “exact”, “ambiguous”, or “poor” visualization in regards to aneurysm neck, aneurysm shape, and parent-vessel branch points. The 2DA and 3DA data both were quantified further based on their usefulness in assessing the embolization potential of each aneurysm. For this they were stratified into embolization being “possible” based only on the study, “not possible” based only on the study, or the study providing “inadequate information” to determine whether the aneurysm could be embolized.

RESULTS

There were 31 patients, 11 men and 20 women (mean age of 53 years), with 35 aneurysms. Of the 35 aneurysms, 18 were ruptured and 17 were unruptured. Twenty-two aneurysms eventually underwent coiling, 12 aneurysms were surgically clipped, and one aneurysm could not be treated with either coiling or surgery. Neck anatomy was visualized exactly, ambiguously, or poorly in 57%, 23%, and 20% of cases with 2DA and in 94%, 3%, and 3% of cases with 3DA, respectively. Similarly, aneurysm shape was visualized in 49%, 37%, and 14% of cases with 2DA and in 94%, 0%, and 6% of cases with 3DA, respectively. Finally, branching patterns were visualized in 29%, 1%, and 1% of cases with 2DA and in 94%, 0%, and 6% of cases with 3DA, respectively. Based upon only the 2DA, embolization was thought to be possible in 49%, not possible in 9%, and there was inadequate information in 43% of cases. With the addition of 3DA, embolization was found to be possible in 68%, not possible in 29%, and there was inadequate information in only 3% of cases.

CONCLUSION

From these results, two unique conclusions can be made. First, 3DA significantly supplements the data on aneurysm neck, aneurysm shape, and parent-vessel branch characteristics provided by 2DA. Additionally, when attempting to assess the embolization potential of an aneurysm, 3DA aids

in establishing the optimal treatment in a large group of aneurysms, 40% of cases in our series, in which 2DA provides only inadequate information.

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KEY WORDS: Cerebral aneurysms, rotational angiography, three-dimensional angiography

Poster 114

Surgically Created Experimental Giant Bifurcation Aneurysms in a Canine Model

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PURPOSE

Large and giant aneurysms are notoriously difficult to treat and have a high recurrence rate. Until recently no reliable giant aneurysm model existed to test new aneurysm occlusion materials/devices. This study shows the creation of a giant bifurcation aneurysm using the canine model.

MATERIALS & METHODS

Four female mongrel dogs weighing approximately 10 kg were used. All surgical procedures were performed under general anesthesia and sterile conditions. Bilateral 8 cm incisions were made in the neck to expose both common carotid arteries. Both external jugular veins were isolated and ligated proximally and distally, and 3 cm segments of vein were excised and placed in heparinized saline (2000 u heparin/20 cc normal saline). An arterial anastomosis was done attaching the end of the left common carotid artery to the lower third of the opening in the right common carotid artery. A long access cut was made in both veins and subsequent 45 degree angle cuts were made on one end of each vein. Both veins then were placed on 28 french dilator. A continuous running suture was used to anastomose both sides of the veins together. The veins then were incorporated into the junction of the common arteries. The top of the vein pouch then was closed using two running continuous sutures. The aneurysmal pouches measured approximately 20 mm x 15 mm with a 9 to 10 mm neck. Postsurgery patency was evaluated by ultrasound.

RESULTS

After 1 month of healing the animals were returned to the surgical suite for angiographic evaluation of the aneurysms which showed that all aneurysms and outflow tracts were patent. Aneurysm size was stable or increased up to 25 mm with 10-14 mm necks.

CONCLUSION

This study shows that large and giant bifurcation canine aneurysms can be surgically created successfully and reliably using jugular veins. This model allows experimental embolization materials/devices to be tested in high flow broad-necked challenging aneurysms.

KEY WORDS: Giant aneurysm, animal model

The authors of this work have indicated the following affiliations/disclosures: MicroVention, Inc.: Consultant, investor.

Poster 115

Comparison of 2D and 3D Digital Subtraction Angiography in Planning Endovascular Treatment of Intracranial Aneurysms

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PURPOSE

The advent of three-dimensional angiography (3DA) has led to better understanding of the morphologic features of vascular intracranial lesions required for more advanced surgical or endovascular procedures. The purpose of this study was to assess the therapeutic impact of 3DA in comparison with two-dimensional subtraction digital angiography (DSA) in the intracranial aneurysms endovascular treatment.

MATERIALS & METHODS

A total of 200 patients who underwent both DSA and 3DA to find brain aneurysms were evaluated. Digital subtraction angiography was performed in standard projections, the 3 DA rotational was performed with a 180°- 220° rotation of the C-arm. This information was transferred to a computer workstation and finally the 3D reconstruction was obtained. Different anatomical parameters were registered. The defect of a cerebral arterial wall was classified as focal or segmental after evaluation of the neck. Parent vessel relation and the overall usefulness of the DSA in comparison with the 3DA data was rated on a three-point scale: 1. Very useful, 2. Sufficient, 3. Poor, according to the diagnosing or excluding the aneurysm presence, the quality of the depiction of the aneurysm neck, the spatial relation to the parent vessel and adjacent vessels, its capacity of providing the best projection (optimal working angle) for embolization and especially the information that helped us to select the best strategy of treatment.

RESULTS

Two hundred patients with 224 intracranial aneurysms were selected. The mean age was 52 years (range, 27-84 years), 12.5% patients with multiple aneurysms. The SAH was the most frequent clinical presentation. Eight-five percent aneurysms were located in the anterior circulation. The arterial wall defect was classified as focal defect in 65% of the cases and segmental defect in 35%. Forty-two patients (18%) had undergone previous treatment. The information obtained and the usefulness of the 3DA in comparison with DSA was evaluated as very useful in 90%, sufficient in 7%,

and poorly assessed in 3%. The choice of the strategy comparing DSA and 3DA information changed in 36 cases (18%). In 144 aneurysms, selective endovascular occlusion with coils or endovascular reconstruction with stents were performed during the same angiographic session. The DSA had a 3.5% rate of false positives. Two technical complications were observed. The procedural morbidity was 0% and the mortality rate was 0%.

CONCLUSION

Technologic advances in cerebral angiography enable more accurate diagnosis of neurovascular diseases. The 3DA constitutes a diagnostic tool useful for intracranial aneurysm evaluation and offers multiple advantages in comparison with DSA in planning endovascular treatment of these conditions. All physicians are encouraged to be familiar with this technology to obtain better clinical results.

KEY WORDS: Aneurysms, 3D angiography, DS angiography

Poster 116

Buenos Aires Experience in the Treatment of Intracranial Aneurysms with Hydrogel-Platinum Coils

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PURPOSE

The purpose of this study was describe the safety, feasibility, and behavior on the time with the use of a new hybrid Hydrogel-platinum coil device - Hydrogel Embolic System (HES) for the treatment of intracranial aneurysms.

MATERIALS & METHODS

Between November 2001 to April 2003 we enrolled 60 patients with 64 aneurysms (38 SAH, 12 with mass effect, and 10 incidentals). Age range 29 to 75 years (mean: 52 years). The device has been designed to entirely fill the aneurysm cavity, with complete or near-complete exclusion of unorganized thrombus for diminish recanalization. The population was classified into two groups in agreement of the characteristic of the aneurysms (size and neck diameter) and technical feasibility: Group A (n = 36) and Group B (n = 24). Angiographic occlusion rate was evaluated immediately posttreatment, at 20 minutes, 24 hours, 3, 6, and 12 months after treatment.

RESULTS

Initial total occlusion was acquired in 65% of group A and 39% of group B. Digital subtraction angiography 20 minutes demonstrated increase of total occlusion rate at 89 - 62% respectively. Recanalization was observed in four patients. Clinical follow-up was performed in all patients and angiographic follow-up in 77%. Technical complications present in six cases. No rebleeding cases were registered.

CONCLUSION

In our experience, HES shows to be safe, feasible and the hydrogel expanded in a predictable way until 20 min. Percentage of occlusion was excellent in group A with not dense packing. More trials and long-term follow-up are needed.

KEY WORDS: Intracranial aneurysm, hydrogel, coils

Poster 117

Relationship between Coil Packing Density and Histologic Outcome after Coil Embolization in Elastase-Induced Aneurysm Model: A Retrospective Study

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PURPOSE

There exists no histologic data correlating packing density with outcome following coil embolization of aneurysms. We report a retrospective study comparing histologic outcome in elastase-induced aneurysms in rabbits following dense coil packing and loose coil packing.

MATERIALS & METHODS

Coil packing density and histologic healing appearances after coil embolization were analyzed in 22 elastase-induced aneurysms in rabbits. Eleven matched pairs of subjects were identified. Each pair had been embolized with similar types of coils and had been implanted for similar durations. Duration of implantation ranged from 2 weeks to 10 weeks following embolization. Volumetric occlusion percentage (coil packing density) was calculated as (PD = volume of coil/volume of aneurysm). We defined dense coil packing as greater than 30% packing density. The histologic features analyzed included neck coverage on gross inspection and histologic processing (no membrane, thin membrane, or thick membrane) and histologic findings within the aneurysm cavity (thrombus, loose tissue, or dense connective tissue with spindle cells). We defined good healing as the presence of a thick membrane across the neck and absence of thrombus within the aneurysm cavity. Chi-square test were used for the comparison.

RESULTS

Among subjects in which dense packing had been achieved, good healing was present in 7 (64%) of 11 cases (Figure 1, hematoxylin and eosin stain showing thick membrane traversing the aneurysm neck). Among subjects that had been loosely packed, 0 of 11 cases showed good healing (Figure 2, hematoxylin and eosin stain showing thin membrane traversing the aneurysm neck). Good healing was significantly more frequent in densely packed aneurysms as compared to loosely packed aneurysms (p = .001).

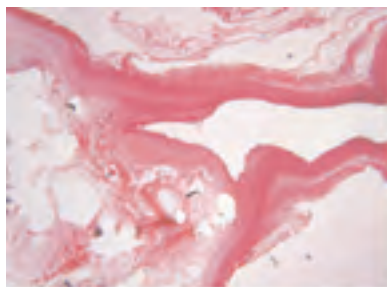


Figure 1

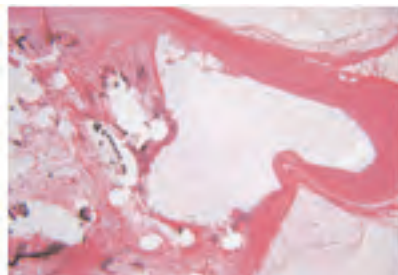


Figure 2

CONCLUSION

Packing density represents an important determinant of histologic healing following coil embolization of experimental aneurysms.

KEY WORDS: Aneurysm, embolization, histology model

The authors of this work have indicated the following affiliations/disclosures: MicroVention: Shareholder; Research grant.

Poster 118

Buenos Aires Experience with Neuroform™ Self-Expanding Stent for Treatment of Intracranial Aneurysms

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PURPOSE

We report our experience in intravascular reconstruction with the Neuroform™ self-expanding stent, assessed the technical feasibility, the efficacy of the combined application of stent and detachable coils and the follow-up in the management of complex wide-necked intracranial aneurysms.

MATERIALS & METHODS

Thirty-seven consecutive patients with a wide-necked intracranial aneurysm were selected for treatment. The strategies consisted of: a) stent deployment to cover the neck of the aneurysm without posterior coil embolization, b) combined approach with subsequent filling of the sac with coils through the stent and c) coil embolization with further stent placement. The performance of the device was evaluated according to flexibility, trackability, radiopacity, and delivery. The final angiographic result was graded as optimal or suboptimal in respect to the stent position if each proximal

and distal tip of the stent was anchored in at least 4 mm of normal vessel with total neck control. Clinical and angiographic follow-up were registered.

RESULTS

Twenty-one female, 16 male, with 45 aneurysms were enrolled. Twenty-eight large, 5 giant, 12 small, five patients with multiple aneurysms. Of the total aneurysms, 40 aneurysms were selected for stent placement. SAH 50%, mass effect 30%, incidentals 20%. The aneurysms were located at the internal carotid artery (n = 26), posterior circulation (n = 6), MCA (n = 8). The technical success with the stent deployment was acquired in 36 cases. The strategy was: Only stent 21%, stent and coils 55.2%, coils and further stent 23.6%. In 2 cases the placement of stent was not possible. Of the 37 cases in which the device was implanted, the angiographic result was optimal in 28 and suboptimal in 9. Technical limitations were registered, especially with the microdelivery system, in 46% a coil pusher was necessary to deploy the stent. Clinical follow-up was registered in all patients: functional independence was observed over the 75%. Angiographic follow-up was obtained at 3-6 months in 50% of the cases. Three cases in which the strategy was stent and coils revealed progressive thrombosis of the sac, neither subacute thrombosis or any hemorrhagic event were registered.

CONCLUSION

In our clinical experience, the Neuroform microdelivery stent system has demonstrate that it can be maneuvered easily and safely through severely tortuous intracranial vessels, enabling the treatment of complex wide-necked aneurysms. Currently, this device offers a promising therapeutic alternative for those lesions not amenable to coil embolization alone in which endovascular reconstruction of the parent vessel is necessary. Technical improvements on delivery system are mandatory to obtain better results during deployment phase. More trials and long-term follow-up are needed to define the precise indications and to determine permanent vessel patency and aneurysm occlusion rate.

KEY WORDS: Aneurysms, stents, HSA

Poster 119

To Evaluate One-Year Experience in the Use of Bioactive Coils in Humans

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PURPOSE

Animal studies using bioactive (Matrix) coils have shown the formation of intraaneurysmal connective tissue, increased aneurysm neck tissue thickness, and reduced aneurysm size. The aim of this study is to evaluate the aneurysm contraction when using polymer-coated coils in humans.

MATERIALS & METHODS

As a part of a prospective multicenter study, 11 patients were enrolled prospectively and treated with bioactive polymer coated Matrix coils. Aneurysms were packed tightly. Follow-

up angiograms were obtained at 3 and 12 months. Measurements of packing density (coil volume/aneurysm volume), and coil mass were performed at each follow-up.

RESULTS

Eleven (9 women, average age 55 years) patients were enrolled. Nine patients had 3- and 12-month angiograms, 1 patient had a 3-month follow-up only and 1 had a 12-month follow-up only. Two aneurysms were at the basilar tip, the remainder were of the anterior circulation. Average coil packing density was 35%. All but 2 patients had unruptured aneurysms. Two patients experienced vasospasm during the initial procedure, another had a residual dog ear postinitial coiling. One patient had coil compaction that required repeat coiling. Three patients had a residual neck not requiring repeat treatment. Only one patient had a significant decrease (50%) in aneurysm area over 12-month follow-up, the remainder of the patients had no significant change in aneurysm area (1-8%).

CONCLUSION

Only one patient had contraction of coil mass on follow-up. The remainder of patients' aneurysms decreased in size of 1-8%. There appears to be no significant advantage in using Matrix coils to induce aneurysm contraction in humans.

KEY WORDS: Aneurysm, polymer-coated coils, matrix

The authors of this work have indicated the following affiliations/disclosures: Boston Scientific/Target Corp.: Consultant.

Poster 120

Volumic Occlusion Improvement by 3D Micrus Coil Embolization of Unruptured Intracranial Aneurysms: Toward an Index Pronostic of Less Risk of Aneurysmal Recanalization?

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PURPOSE

Percentage of aneurysmal volumic occlusion using coils, particularly when it exceeds 25%, is an index pronostic of less risk of recanalization. However, wide-necked aneurysms constitute a persistent challenge for endovascular therapy. Our purpose was to evaluate the postoperative aneurysmal occlusion and clinical results of treating unruptured intracranial aneurysms using three-dimensional coils.

MATERIALS & METHODS

Over a 2-year period, 62 aneurysms (39 with a neck 4 mm, group A; 23 with a neck > 4 mm, group B) in 62 patients in 5 participating centers were consecutively treated. Forty-nine aneurysms were small (< 10 mm), and 13 were large (10-24 mm). The procedure consisted, first of framing the aneurysm with one or more spherical Micrus microcoils,

second, of filling it with helical Micrus microcoils. Results were evaluated by univariate analysis. Multivariate analysis was used to identify independent predictors of these results.

RESULTS

Angiographic occlusion was complete in 31 (79%) and 16 (70%) aneurysms in groups A and B respectively. Mean percentage of volumic occlusion in these groups was 31.4 and 29.5% respectively. Postoperative morbidity rates were 3% and 4% in groups A and B respectively. There was no mortality. Anatomical and clinical results were not significantly different between the two groups. However, percentage of volumic occlusion correlated with sac size ($P = 0.037$), and sac-to-neck ratio < 1.5 ($P = 0.073$), except when 3 or more three-dimensional coils per aneurysm were used ($P = 0.516$, and 0.308 respectively). The better the percentage of volumic occlusion, the better the percentage of angiographic occlusion ($P < 0.001$). Percentage of volumic occlusion was an independent predictor of angiographic complete occlusion ($P = 0.002$). No predictor of postoperative clinical results emerged.

CONCLUSION

The use of three-dimensional coils was safe and may improve the angiographic and volumic occlusion of aneurysms with a neck > 4 mm, at the time of treatment, provided the sac-to-neck ratio was 1.5 or greater, and the largest number of three-dimensional coils were positioned first.

KEY WORDS: Unruptured aneurysms, 3D coils, endovascular therapy

Poster 121

Angiographic Follow-Up 3-6 Months in Patients Treated with Hydrocoils (a New Self-Expanding Coated Coil)

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PURPOSE

Conventional noncoated coils create a higher risk for coil compaction and aneurysm neck regrowth. We have evaluated aneurysm neck regrowth/coil compaction in patients treated with Hydrocoil, as well as the safety and efficacy of using Hydrocoils to treat intracranial aneurysms including wide neck aneurysms.

MATERIALS & METHODS

Twenty-seven patients with 27 aneurysms were treated with Hydrocoils at our institution since October 2002. There were 23 anterior circulation and 4 posterior circulation aneurysms with 9 presenting as subarachnoid bleed. Twenty-one were new, and 6 had regrowths after previous bare coil treatment. Seven patients were treated with a bridging Neuroform stent device, and 4 underwent a balloon remodeling technique. Twenty-three of the 27 aneurysms presented with wide necks having a dome/neck ratio < 2 or an absolute neck of 4 mm or greater.

RESULTS

Technical success was achieved in all 27 cases, with > 95% occlusion in 25 cases. Two patients had < 90% occlusion at initial treatment; however, at 6-months follow-up 1 aneurysm showed complete thrombosis, while the second showed no change in the neck remnant. Sixteen of the 27 aneurysms had at least a 3-month follow-up, with no regrowth or coil compaction in any of these cases.

CONCLUSION

The use of Hydrocoils in the treatment of intracranial aneurysms is a viable treatment and may decrease the rate of recanalization in cerebral aneurysms including those with wide necks. Complications are low after an initial learning curve.

KEY WORDS: Aneurysm, hydrocoil, endovascular

Poster 122

Orbital Venous Outflow Patterns and Its Relation to the Conjunctival Symptoms in Patients with Cavernous Sinus Dural Fistulas

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PURPOSE

To report the angiographic pattern of the orbital venous outflow before endovascular treatment and its relation to the conjunctival symptoms in patients with cavernous sinus dural fistulas (CSDF).

MATERIALS & METHODS

Thirty-one patients with CSDF draining into the orbit were enrolled. Venous outflow pattern of these patients was described in detail, being related to their conjunctival symptoms before and after endovascular treatment.

RESULTS

In 21 of the 31 patients, the superior ophthalmic vein (SOV) and inferior ophthalmic vein (IOV) were patent before treatment regardless of the flow direction. Conjunctival symptoms of these 21 patients disappeared within 3 weeks after treatment. In the remaining 10 patients, SOV and/or IOV were found to be angiographically thrombosed. Collateral venous drainage patterns of these 10 patients were classified into 4 groups; I: draining into the frontal vein through the apsidal veins (n = 3), II: draining into the facial vein through the apsidal veins (n = 2), III: draining into the pterygoid plexus through IOV via the inferior orbital fissure (n = 1), IV: no angiographic venous collateral routes disclosed (n = 4). In all the patients in groups I, II, and III, conjunctival symptoms disappeared within 3 weeks, but in the 4 patients in group IV, conjunctival symptoms persisted for 2-6 months after treatment.

CONCLUSION

Detailed evaluation of the angiographic orbital venous collaterals is important and useful to predict the prognosis of conjunctival symptoms after endovascular treatment.

KEY WORDS: Cavernous sinus dural fistula, orbital venous collaterals, embolization

Poster 123

Transarterial Balloon-Assisted N-Butyl-2-Cyanoacrylate Embolization of Direct Carotid Cavernous Fistulas

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PURPOSE

To present our experience with transarterial balloon-assisted N-butyl-2-cyanoacrylate (NBCA) embolization of direct carotid-cavernous fistulas (DCCFs) in which failure to achieve angiographic cure with preservation of parent arteries by transarterial balloon embolization.

MATERIALS & METHODS

Over 12 years, 128 out of 156 patients with traumatic DCCF were managed by transarterial embolization with occlusion of the fistula and parent artery preservation. Of them, 18 patients received transarterial balloon-assisted NBCA embolization (TBNE) after detachable balloon(s) and coils placement. The indications of TBNE were residual fistula after balloon(s) detached (n = 6), recurrent fistula because of premature balloon deflation or migration (n = 7) and repeated puncture of the detachable balloon by the bony fragment at the cavernous sinus (n = 5). A total of 27 procedures was performed with an average 1.6 attempts per patient and the volume of NBCA mixture varied from 0.4 to 2.3 ml with a mean of 0.83 ml.

RESULTS

All DCCFs were occluded successfully by NBCA mixture with preservation of parent arteries on immediate postembolization angiography. One patient with a giant CS varix had a fatal subarachnoid hemorrhage. One patient had a recurrence and was managed by ICA occlusion. Seven patients had asymptomatic pseudoaneurysms at the parent artery. No evidence of adhesion of NBCA mixture to the protective balloon or microcatheter was observed, nor reflux of the NBCA mixtures into the parent arteries was shown. The clinical follow-up periods were 1 week to 3 years (mean 17 months).

CONCLUSION

Transarterial balloon-assisted NBCA embolization is a feasible, efficient, and safe treatment for those DCCFs in which failure of angiographic cure with ICA preservation by traditional transarterial detachable balloon embolization.

KEY WORDS: Direct carotid-cavernous fistula, embolization, n-butyl-2-cyanoacrylate

Poster 124**Dural Arteriovenous Fistula of the Cavernous Sinus with Retrograde Cerebellar-Pontine Venous Drainage: Report of Two Cases and Literature Review**

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PURPOSE

Dural arteriovenous fistulas (DAVFs) with retrograde cerebellar-pontine venous drainage (RCVD) have a high risk of aggressive symptom, such as intracranial hemorrhage and central nervous palsy, majority of which locate at transverse-sigmoid sinus or tentorium. We present two rare cases of cavernous sinus (CS) DAVF with RCVD which were treated successfully by transvenous embolization (TVE), and discuss their clinical symptoms, drainage routes, and treatments with literature review.

MATERIALS & METHODS

Case 1 was an 81-year-old woman with ocular symptoms for 7 months. Case 2 was a 69-year-old woman with right ocular symptoms and trigeminal pain gradually deteriorated for 6 months. Diagnostic imaging included postcontrast CT, MR imaging, and angiography in both cases. We also reviewed cases with cavernous DAVF with RCVD published between 1970 and 2003.

RESULTS

Case 1: Postcontrast CT showed mild dilatation of the right superior orbital vein (SOV) and left cerebellar cortical veins. On MR images abnormal flow voids were noted in the right cavernous sinus, the left superior petrosal sinus (SPS), and the left petrosal vein. Cerebral angiography showed a DAVF of the left cavernous sinus and intercavernous sinus. The SPS and inferior petrosal sinus (IPS) were occluded and the DAVF drained mainly into the left cerebellar veins through the petrosal vein. Another drainage route to the right SOV through the posterior intercavernous sinus also was observed. The left vertebral angiogram showed venous congestion of left posterior fossa. Case 2: Axial T2-weighted MR images showed a dilated right SOV and abnormal flow voids in the right cavernous sinus. Postcontrast CT revealed dilatation of the right SOV and cerebellar cortical veins. Cerebral angiography showed DAVF of the right cavernous sinus with reflux to right SOV. The SPS and IPS were occluded and the DAVF drained mainly into the right cerebellar veins through the petrosal vein. The left vertebral angiogram showed venous congestion of right posterior fossa. Treatment: The both patients were treated by TVE through the occluded IPS with detachable coils. The DAVFs were occluded completely. The symptoms improved and venous congestion of posterior fossa disappeared at follow-up in both patients. From literature review, 5 cases of CSDAVF with RCVD were encountered. All seven patients, including 5 cases previously reported and present cases, had ocular symptoms and 4 patients showed aggressive symptoms including one cerebellar hemorrhage. Common drainage veins of RCVD included the petrosal vein and the lateral mesencephalic vein. All patients were treated by TVE (n = 4), transarterial embolization (TAE) with particles (n = 2), or combined TAE and irradiation (n = 1). All 4 DAVF

treated by TVE and one case treated by combined TAE and irradiation cured. Two cases treated by TAE alone were cured incompletely.

CONCLUSION

Although CSDAVFs can be treated conservatively based on their nonaggressive drainage pattern, careful attention should be paid that CSDAVFs could be associated with RCVD with thrombosis/restriction of the main outlet of the CS. Dilatation of cerebellar veins or the petrosal vein on MR or CT images suggests RCVD which requires more aggressive treatment.

KEY WORDS: Cavernous sinus dural arteriovenous fistula, retrograde cerebellar-pontine drainage, endovascular treatment

Poster 125**Hemodynamic Status and Treatment of Aggressive Dural Arteriovenous Fistulas**

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PURPOSE

To evaluate the hemodynamic status and treatment modality of aggressive dural arteriovenous fistulas (dAVFs).

MATERIALS & METHODS

Of 135 dAVFs which were treated in our clinic, there were 35 aggressive lesions which presented with hemorrhage, infarction, convulsion, and symptoms of increased intracranial pressure. They included 3 (5% of all cavernous sinus lesions) cavernous sinus, 22 (42%) transverse-sigmoid and superior sagittal sinuses, and 10 (48%) direct cortical type dAVFs.

RESULTS

Of these 35 aggressive lesions, the retrograde leptomeningeal venous drainage was disclosed in 32 lesions, and the retrograde sinus drainage in 3. Fifteen cases were treated only with endovascular procedures, 6 with surgical intervention, and 14 with combined endovascular and surgical procedures. Angiographic results were complete obliteration in 74% of the cases, subtotal and partial obliteration in 26%. Clinical outcome was GR in 63% of the cases, MD in 11%, SD in 11%, VS in 11%, and D (acute cardiac infarction) in 3%. Symptomatic procedural complication occurred in 2 cases.

CONCLUSION

Aggressive dural AVF resulted from retrograde leptomeningeal venous drainage. Combined surgical and endovascular treatment played the leading part in the management of this aggressive lesion.

KEY WORDS: Dural arteriovenous fistula, endovascular treatment

Poster 126

Spinal Cord Arteriovenous Malformation Associated with Feeding Artery, Intranidal and Renal Artery Aneurysms in a Case with “Hypermobile Joint Syndrome”

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PURPOSE

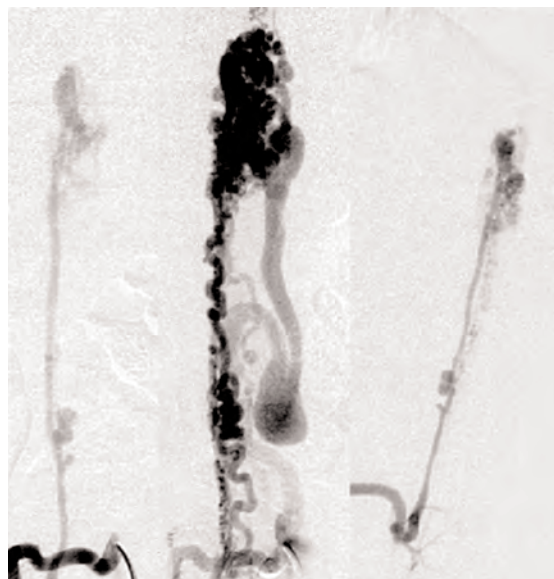
Spinal cord arteriovenous malformations (SCAVMs) rarely have been reported in association with disorders such as neurofibromatosis and Renu-Osler-Weber syndrome. We report a case of SCAVM associated with connective tissue disorder - “benign hypermobile joint syndrome.” This association has not been reported in the literature previously.

MATERIALS & METHODS

Retrospective review of a case of SCAVM associated with connective tissue disorder - “benign hypermobile joint syndrome” - was performed, including result of endovascular embolization of one of the aneurysms. The clinical and radiologic details including the follow-up imaging were studied.

RESULTS

An 18-year-old male presented with history of pain in lower back radiating to right lower limb since 6 years. He complained of slowly progressive weakness and numbness in right leg and foot since 1 year with power being 4/5 at hip, knee, and ankle. He also was found to have hypermobile joints, thin sclera, varicose vein in right lower limb, anemia, and pansystolic murmur in mitral and aortic regions. Echocardiography showed dilatation of left ventricle and left atrium along with floppy mitral valve. On basis of these features, a connective tissue disorder was suspected, and diagnosis of “Benign hypermobile joint syndrome” was made. MR imaging showed an intramedullary AVM at D11-D12 level. MR imaging of brain was normal. Digital subtraction angiography (DSA) showed a intramedullary SCAVM at D11 - D12 level with main feeder from radiculopial branch of right 2nd lumbar artery and smaller feeder from radiculopial branch from left 10th intercostal artery and radiculomedullary artery arising from left 5th intercostal artery. Multiple aneurysms in the feeding artery and in the nidus were seen along with aneurysmal dilatation of the draining vein. He also was found to have multiple aneurysms in renal artery branches bilaterally. Focal dilatation of right renal vein and diffuse dilatation of IVC also were noticed. Embolization of the AVM was done through right second lumbar artery. Microcatheter injection showed jet of contrast apparently into the subarachnoid space. Rupture of AVM was suspected and the nidus was embolized immediately with glue (Histoacryl). Postembolization angiogram showed complete occlusion of the feeder. Postoperative course was uneventful with no new symptoms. Postoperative CT and MR imaging showed evidence of glue in the nidus with no obvious hematoma in the cord. CT head was also normal.



CONCLUSION

Rarely connective tissue disorder such as “benign hypermobile syndrome” may be associated with SCAVM. This particular association should be looked for in cases with SCAVM associated with multiple aneurysms, or if associated aneurysms are found in vascular system outside the CNS. Endovascular intervention in such cases should be undertaken with precaution because of increased fragility of the blood vessels.

KEY WORDS: Spinal cord arteriovenous malformation, benign hypermobile syndrome, nidus rupture

Poster 127

Comparison of Radiosurgical Treatment Outcomes in Embolized and Nonembolized AVMs: A Propensity Score Approach

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PURPOSE

Stereotactic radiosurgery is a desirable and effective treatment option for patients with AVMs; however it is not free from significant morbidity and mortality upon treatment failure. Given the range of treatment options available to AVM patients (endovascular embolization, surgical resection, radiosurgery, or a multimodal combination of them), it is essential that the risks and factors associated with treatment failure be exposed. To do so helps ensure that radiosurgery and the multimodal treatment of embolization and radiosurgery are prescribed in the most advantageous contexts and safest manner.

MATERIALS & METHODS

A retrospective cohort analysis of 200 patients who received stereotactic radiosurgery [linear accelerator (LINAC)] treatment at the Toronto Sunnybrook Regional Cancer Centre (TSRCC)—one of the largest data bases of arteriovenous malformation patients in North America—between 1989 and 2001. Survival analysis (with AVM hemorrhage as the outcome of interest) for radiosurgically and multimodally treated AVMs is being performed using a propensity score method to permit comparisons between treatment quintiles.

RESULTS

Our hypothesis is that multimodal endovascular embolization and radiosurgery treatment is more successful than radiosurgery alone in the treatment of cerebral AVMs.

CONCLUSION

Final results will be available shortly, and for inclusion in the poster presentation at ASNR 2004.

KEY WORDS: Arteriovenous malformation, radiosurgery, embolization

Poster 128**Complete Obliteration of Dural Arteriovenous Malformations with Onyx**

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PURPOSE

To describe a possible endovascular treatment of dural arteriovenous malformations (DAVMs) at the falx and tentorium.

MATERIALS & METHODS

Dural arteriovenous fistulae at the falx and dorsal tentorium drain into cortical veins exclusively and their most common mode of presentation is hemorrhage. As they have collateralizing supply their treatment is an endovascular challenge. A transvenous approach is impossible in most cases in this anatomy and obliteration via an transarterial embolization with particles or glue usually is not achieved so that then surgery has to be instituted. We observed two patients with dural arteriovenous fistulae (DAVFs) at these locations in whom with a single step embolization after microcatheterization of the dominating feeding artery with Onyx was performed to occlude the fistula.

RESULTS

In both cases complete obliteration of the fistula was documented. The mode of the penetration of the Onyx into the fistulous nidus suggests that the cavernous spaces in the dura mater as described by Rowbothom and Little (1), which play an important role in the discussion of the pathogenesis of DAVF, may exist.

CONCLUSION

Onyx offers the possibility to completely obliterate anatomically complex multiarterialized dural AVMs by a single feeder embolization.

REFERENCES

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KEY WORDS: Onyx, DAVF

The authors of this work have indicated the following affiliations/disclosures: 1. MTI: Consultant/Proctor; 2. Boston Scientific: Proctor.

Poster 129**Ex-Vivo Studies of the Neuroform Stent Using Transparent Human Intracranial Arteries**

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PURPOSE

Although increasing clinical experience has been gained with the Neuroform (NF) micro-stent over the past year, a variety of technical problems have been encountered with positioning and deployment that are difficult to resolve, owing to the radiolucency of the majority of the stent. Therefore, the purpose of this study was to attempt to better assess the behavior of the NF by direct visualization within actual human intracranial (IC) arteries using an adaptation of a novel method of creating transparency of the harvested vessels.

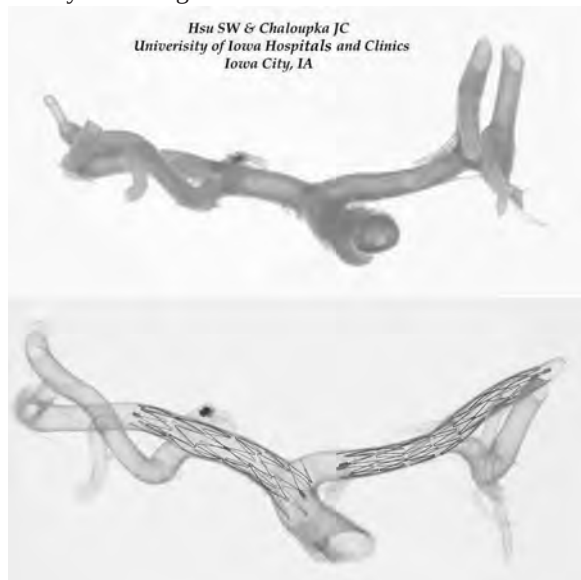
MATERIALS & METHODS

Seven segmental human cadaveric intracranial arteries were obtained from the gross anatomy laboratory. Long arterial segments were dissected from the brain, including the cavernous segment of internal carotid artery (ICA), distal ICA to middle cerebral artery (MCA), distal ICA to anterior cerebral artery (ACA), vertebrobasilar junction (VBA), basilar arterial trunk (BA), and BA to posterior cerebral artery (PCA). Neuroform 2 (NF2) stents were either sized appropriately or oversized, and deployed into one of the above arterial segments, using the push-pull techniques commonly used in clinical applications. The harvested arterial segments were treated with standard dehydration techniques followed by immersion into Wintergreen Oil (Methyl Salicylate). Stent deployment, conformity, cell configuration, and scaffolding were evaluated by digital photography in multiple views. Assessment of the morphologic situation in different arterial segments, the interphase of stent and arterial wall, and relationship of stent with side branches were studied.

RESULTS

NF2 stents have an open cell, segmental connection of a zigzag Nitinol rings, in which each segment has only two connection points with adjacent segments with 90° differences. Preliminary results showed that the NF2 overall exhibited very good conformity to the stented arterial segment when sized appropriately. However, a few important potentially adverse properties were seen as follows: 1) deployment into larger curvatures resulted in lack of attachment of the stent

ends to the arterial wall, 2) portions of the crown may protrude into the side branches when the size of the stent is larger than the parent vessel and the connection point of stent is not at the interface of the parent artery and/or side branch orifice, 3) the gap in between stent crowns could be considerably larger than expected in the segments with acute or abrupt angulation, and 4) the radial force exerted by the NF could straighten some arterial segments, particular those with very acute angulation.



CONCLUSION

Transparent human IC arterial segments are excellent models for evaluating certain important physical properties and behavior of radiolucent stents such as the NF2. Our preliminary studies already reveal several important findings. Proper sizing appears to be particularly important for ensuring good stent conformity within the arterial segments, particularly when significant curvature is encountered. Conversely, NF2 deployment in segments/branches of acute angulation can be problematic, potentially resulting in excessive gaps in between segments that likely will not provide adequate scaffolding for containing coils within an aneurysm.

KEY WORDS: Neuroform stent, aneurysms, transparent artery model

Poster 130

Three-Dimensional Cerebral Angiography: Radiation Dose Comparison with Digital Subtraction Angiography

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PURPOSE

To evaluate patient radiation dose associated with three-dimensional rotational angiography (3D RA) of the head, as compared with biplane digital subtraction angiography (DSA). This evaluation includes assessment of the location

and magnitude of the peak skin dose, as a measure of deterministic effects risk, and the cumulative dose, as a measure of stochastic radiation risk.

MATERIALS & METHODS

To acquire images for 3D RA, the frontal C-arm of an angiography system (Neurostar Plus, Siemens) was rotated in a 200 degree arc with the x-ray tube traveling under the patient table. A total of 162 images in the 30 cm image intensifier (II) field-of-view (FOV) were acquired in two rotational arcs for contrast and mask images. For the biplane DSA acquisition, the following technique parameters were used to characterize a typical DSA run: 22 cm II FOV and 18 frames for both frontal and lateral projections, 20 degrees cranial angulation for the frontal C-arm. The distribution of the entrance skin dose was measured with direct exposure film (XV-2 Ready-Pak, Eastman Kodak) wrapped around the surface of an anthropomorphic skull phantom (Alderson angiographic head phantom, Cone Instruments). Once the location of the peak skin dose was determined, the dose was measured there using a skin dose monitor (SDM Model 104-101, McMahon Medical) that was calibrated with an external ionization chamber. The cumulative dose, summed over all images in each acquisition, was measured using the angiography unit's integrated dosimetry system. This system calculates air kerma at the reference distance of 60 cm from the X-ray source by measuring the dose-area-product and dividing by the exposure entrance port at that distance as determined by the collimator positions. The air kerma value was calibrated and corrected to account for table and pad attenuation and the actual source-skin distance.

RESULTS

The skin dose distribution for a 3D RA acquisition was spread uniformly around the back and sides of the head. The peak skin dose, located at the back of the skull, was 15 mGy. For a biplane DSA run, the peak skin dose was 58 mGy, also located at the back of the skull. The skin dose for the lateral projection was 17 mGy. The cumulative dose for a 3D RA acquisition was 34 mGy, compared to the biplane DSA run cumulative dose of 53 mGy.

CONCLUSION

Though 3D RA requires the acquisition of many more images than a typical biplane DSA run, the patient radiation dose for 3D RA is considerably lower: nearly a factor of four lower in peak skin dose and 40% lower in cumulative dose. Note that acquisition of only the contrast rotational arc for 3D reconstruction of unsubtracted images will reduce 3D RA doses by an additional factor of two. There is a potential for significant patient radiation dose savings if 3D RA acquisitions are substituted for one or more biplane DSA runs during interventional neuroradiology procedures.

KEY WORDS: Three-dimensional angiography, radiation dose, digital subtraction angiography

Poster 131

Emergency Carotid Stenting for Acute Ischemic Stroke Patients: A Clinical Pilot Study

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PURPOSE

It remains unclear how to treat patients with symptoms-related total occlusion or a high-grade stenosis of the internal carotid artery (ICA) in acute stroke stage. The purpose of our study was to investigate the feasibility, safety, and efficacy of emergency carotid stenting (ECS) for symptomatic ICA lesions in acute ischemic stroke patients within 7 days of the onset.

MATERIALS & METHODS

A nonrandomized clinical pilot study was conducted. Inclusion criteria of the study were 1) patients admitted between July 2000 and June 2003, 2) serious neurologic symptoms defined as National Institutes of Health Stroke Scale (NIHSS) score of 5 or more, 3) total occlusion or a high-grade stenosis ($\geq 70\%$ measured by NASCET method) of the ICA associated with symptoms, and 4) decrease of cerebral blood flow demonstrated by perfusion-weighted MR images or single photon emission computed tomography scans ipsilateral to the ICA lesion. Exclusion criteria were a large infarction with high-signal intensity detected by means of diffusion-weighted MR images and patients with contraindication of arteriography. Primary endpoints were the NIHSS at 7 days and the modified Rankin scale (mRS) at 3 months after the procedure. Secondary endpoints were procedure-related complications, restenosis, recurrence of any strokes, and any death.

RESULTS

Emergency carotid stenting was performed in 17 (male 13, mean age 69.9 $\pm$ 13.4) of 896 acute ischemic patients (1.9%). The mean elapsed time from onset to ECS was 56.3 $\pm$ 57.6 hours. The mean degree of ICA stenosis was 96.0 $\pm$ 6.5% involving 4 lesions of total occlusion, and there was a technical success of 100% with 17 carotid arteries treated, in which balloon-expandable stents were used for 11 arteries. The median NIHSS score at 7 days improved significantly in comparison with that on admission (5, 9, respectively; $P < 0.05$, Wilcoxon's rank sum test). Ten patients (58.8%) had favorable outcome (mRS 0/1), three patients sustained a minor stroke (mRS 2/3), and four patients had a major stroke (mRS 4/5) at 3 months, while one patient (5.9%) died from congestive heart failure 10 days after the procedure. Neither restenosis at 3 months nor ipsilateral stroke within 3 months after procedure occurred. Two (11.7%) procedure-related complications occurred: intracranial hemorrhage and distal embolism.

CONCLUSION

Emergency carotid stenting can improve 7-day clinical outcome, and probably improve 3-month clinical outcome.

KEY WORDS: Emergency carotid stenting, acute ischemic stroke, angioplasty

Poster 132

Evaluating the Use of Specific Absorption Rate as a Dosimeter of MR Imaging-Related Implant Heating

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PURPOSE

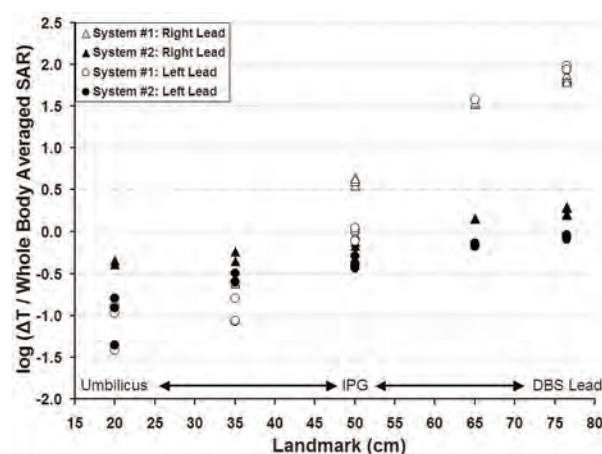
To compare the MR imaging-related heating per unit of whole body averaged specific absorption rate (SAR) of a conductive implant exposed to two different 1.5 T/64 MHz MR systems.

MATERIALS & METHODS

Temperature changes at the the most distal contact of each of the two bilaterally-placed deep brain stimulation leads were measured using fluoroptic thermometry. The leads were placed in a typical surgical implant configuration within a gel-filled phantom of the human head and torso. MR imaging was performed using two different transmit/receive body coils on two different generation 1.5 T MR systems from the same manufacturer (System #1 vs System #2). Temperature changes were normalized to whole body averaged SAR values and compared between the two scanners at five different MR landmarks.

RESULTS

The findings support a linear relationship between SAR and heating within a given type of MR system, where the observed temperature change was highly correlated ($r = 0.99$, $p < 0.01$) with whole body averaged SAR. However, depending on the landmark location (Figure), the normalized temperature change for the implant was significantly higher on one MR system compared to the other, with the maximum difference observed when the MR system was landmarked at the level of the DBS electrodes ($p < 0.001$).



CONCLUSION

The findings revealed marked differences across two MR systems in the level of RF-induced temperature changes per unit of whole body SAR for a conductive implant. Thus, these data suggest that using SAR to guide MR safety recommendations for neurostimulation systems or other similar implants across different MR systems is unreliable and, therefore, potentially dangerous. Better, more universal, measures are required in order to ensure patient safety.

KEY WORDS: Heating, specific absorption rate, MR imaging

Poster 133

Short-Term Clinical Outcome Following Endovascular Treatment for Intractable Long-Segmental Total Occlusion of the Vertebrobasilar Artery in Acute Ischemic Stroke Patients

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PURPOSE

Clinical outcome of acute stroke patients with serious neurologic symptoms due to long-segmental total occlusion (LTO) of the vertebrobasilar artery (VBA), in which no VBAs are displayed in MR angiograms, is usually poor and LTO of the VBA looks intractable. Endovascular treatment (ET) such as intraarterial fibrinolysis, cerebral balloon angioplasty (CBA), cerebral artery stenting (CAS), or their combination for recanalization of LTO is promising, however, the effectiveness, safety, and clinical outcome of ET for LTO of the VBA remain unknown. The aim of the study is to investigate retrospectively short-term clinical outcome following ET for LTO of the VBA in acute ischemic stroke patients.

MATERIALS & METHODS

Between April 2000 and June 2003, consecutive 1091 ischemic stroke patients were admitted to the authors' institution within 48 hours of stroke onset. Among them, 6 patients with the median NIHSS of 20 (10-36) due to LTO of the VBA underwent ET on the admission day in an acute stroke stage. Their median age was 74 years (57-77 years). Three patients underwent CAS and other three patients were treated with combination of CBA and intraarterial urokinase (IA-UK). They had no premedication of antiplatelets. NIHSS score 7 days after the onset (NIHSS-7) and modified Rankin scale (mRS) on their discharge day were evaluated.

RESULTS

Complete recanalization was achieved immediately after CBA or CAS in all patients. Median duration of in-hospitalization was 20 days (13-51). Median NIHSS-7 score was 14 (4-32) and median mRS was 5 (3-6). There looked a difference between NIHSS score on admission and NIHSS-7, however, median mRS was not good. In 3 patients who underwent CAS, reocclusion occurred within 7 days and NIHSS-7 (median: 31) was not improved and their mRS was 5 or 6. In contrast, the VBA remained open 7 days after ET in 3 patients who underwent combination therapy of CBA and IA-UK and their NIHSS-7 (median 10) was better and mRS was 3 or 5.

CONCLUSION

Endovascular treatment can recanalize LTO of the VBA looking intractable. However, reocclusion may occur within 7 days following emergency CAS without premedication of antiplatelets and make their clinical outcome worse. If early reocclusion is prevented, clinical outcome can be improved even in acute stroke patients presenting serious neurological symptoms due to LTO of the VBA.

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KEY WORDS: Vertebrobasilar artery, stent, angioplasty

Poster 134

Interventional MR Imaging with an Endospinal Imaging Coil: Preliminary Results with Anatomical Imaging of the Canine and Cadaver Spinal Cord

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PURPOSE

To determine the feasibility of endospinal MR imaging and compare signal-to-noise ratio (SNR) with that obtained by an optimal external surface coil.

MATERIALS & METHODS

A human cadaver subject was obtained via an institutional willed body program. A live canine subject was obtained following approval from the Institutional Animal Care and Research Advisory Committee. In both subjects, X-ray-guided percutaneous access to the spinal subarachnoid space was obtained using a micropuncture set and vascular sheath. A 100 cm length, .032 inch diameter loopless antenna/guidewire (Intercept vascular coil; Surgi-Vision, Inc., Gaithersburg, MD) then was advanced to the T4 level. Imaging was performed on a 1.5 T system with 33 mT/m gradient coils. Several sequences were evaluated for endospinal imaging (Table 1). Images obtained with the endospinal coil were compared with images obtained from a linear surface coil. Signal-to-noise ratio was determined for the thoracic spinal cord using both techniques. The SNR was calculated as follows: Mean $\frac{\text{tissue signal}}{\text{noise}}$ / Standard Deviation $\frac{\text{tissue signal}}{\text{noise}}$.

RESULTS

Results comparing SNR in the thoracic spinal cord for the two coils are shown in Table 2. Using a fast spin-echo (FSE) T2 sequence SNR gain with the endospinal coil varied from 193.37% to 164.22%. Using a steady state free precession (SSFP) sequence a 91.58% SNR gain was seen with the endospinal coil. Using the endospinal coil, high-resolution (0.23 mm x 0.23 mm x 3 mm) FSE T2-weighted images of the canine thoracic spinal cord were obtained with an SNR of 18.03 (Figure).

Table 1

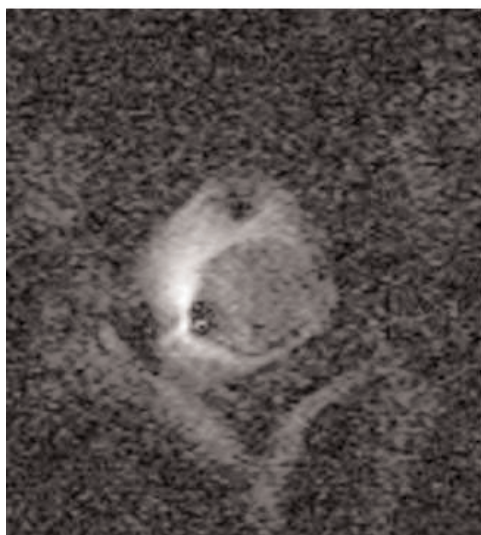
Sequence parameters used in anatomic endospinal imaging

Type	NSA	TR (ms)	TE (ms)	Flip Angle	TSE Factor	% Scan	Slice (mm)	FOV	RFOV	SR (mm)
TSE	1	4000	100	90	12	70	3	6	70	0.23 x 0.23
TSE	1	4055.8	100	90	14	70	5	10	80	0.39 x 0.39
TSE	1	1150	110	90	35	90	3	16	80	0.62 x 0.62
SSFP	3	3.7	1.85	55	NA	50	15	25	75	0.98 x 0.98

Table 2

Comparison of SNR obtained with surface and endospinal coils

	TSE 0.62 mm x 0.62 mm SR	TSE 0.39 mm x 0.39 mm SR	SSFP
Surface coil	22.46	13.5	69.23
Endospinal coil	65.89	35.67	132.63
% SNR gain	193.37	164.22	91.58



CONCLUSION

We are able to demonstrate the acquisition of high SNR and high-resolution anatomical images of the spinal cord utilizing an endospinal coil. Endospinal MR imaging represents a unique potential opportunity for neurointerventional MR imaging, especially when one considers that the endospinal coil also may serve as a guidewire during spinal procedures. While our initial results are promising, future work is required in order to determine threshold resolution, contrast and SNR needed to detect various pathologies of the spinal cord, as well as the applicability of advanced MR methods to endospinal MR imaging. This will be the focus of future investigation.

KEY WORDS: Interventional, MR imaging, endospinal

The authors of this work have indicated the following affiliations/disclosure: Philips Medical Systems: Employee

Poster 135

Endovascular Management of Carotid Blowout Syndrome: Lessons Learned

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PURPOSE

Carotid blowout syndrome refers to an acute, life-threatening transoral or cervical hemorrhage attributable to the carotid artery system (1). Although carotid blowouts obviously may be related to trauma to the neck, they occur most commonly in patients with head and neck squamous cell carcinoma. Known predisposing factors are: 1) previous radical neck dissection, 2) previous radiation therapy to the neck, 3) the presence of infection with or without a fistula, 4) cancer recurrence surrounding the carotid artery or its branches. Although previously thought to involve primarily the internal carotid artery (ICA), it now is recognized that the responsible artery is commonly the external carotid artery (ECA) or one of its branches (2). Endovascular treatment often used to involve internal carotid sacrifice (3) but with the advent of stents, sparing of the vessel should become the rule.

MATERIALS & METHODS

We retrospectively reviewed all carotid blowout syndromes treated at our institution in the past 3 years. A total of 20 procedures were performed in 18 patients. In 13 patients, carotid blowout was secondary to head and neck cancer and in 5 to trauma (4 due to gunshots, one due to a stab injury). In two patients with cancer, embolization had to be repeated for successful control of hemorrhage, in one using a carotid stent.

RESULTS

In all patients, endovascular management resulted in control of the hemorrhage. There were no neurologic complications in any of the patients. In 5 trauma patients, external carotid artery embolization was sufficient in 4, while one patient with a stab wound to the cheek had to be treated with a combination of stent and coils. Out of 13 patients with cancer, 7 were treated with a combination of ICA stenting and ECA coiling, while 6 were treated with ECA particulate and coil embolization. Despite the fact that neither antiplatelet agents nor heparin were used, none of these patients experienced a stroke. No recurrence of hemorrhage was observed.

CONCLUSION

The management of carotid blowout syndrome remains a challenge. This data supports the concept that common or internal carotid artery sacrifice should become distinctly unusual as experience with carotid stenting develops. Successful control of hemorrhage commonly requires a careful and planned combination of stenting to protect the ICA and ECA coil obliteration. Thrombo-embolic risks in relation to the use of stents are minimal with proper technique.

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KEY WORDS: Carotid blowout syndrome, endovascular management, stent

The authors of this work have indicated that they will be discussing/presenting an unapproved/investigative use of a carotid stent made by Cordis/Johnson & Johnson.

Poster 136

Preliminary Experience and Early Follow-Up Using Matrix Coils at the Montreal Neurological Hospital

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PURPOSE

The Matrix coils have been available recently for the treatment of intracranial aneurysms. We report our preliminary experience in the use of Matrix coils in combination with Ultrasoft GDC and occasionally Neuroform stent.

MATERIALS & METHODS

Since June 2003 we have used Matrix coils as a primary coil for the treatment of intracranial aneurysms. Twenty patients have been treated. Thirteen patients presented as acute subarachnoid hemorrhage; two patients had recanalization of previously treated aneurysms with GDC. One case was a giant internal carotid artery aneurysm which had failed test balloon occlusion of the carotid before and following IC-EC by pass. In four cases due to the large neck of the lesion Neuroform stents were used also. All the patients who had acute subarachnoid hemorrhage underwent a 3-months control angiogram. The next control angiogram will be performed at 6 months in all patients.

RESULTS

The different types of Matrix coil have been used in our series. No difference in the advancement or deployment of the coil was observed when compared with the regular GDC. The Matrix coils must be immersed in sterile saline solution for at least 30 seconds prior to delivery in the microcatheter to avoid friction that could potentially damage the PGLA coating of the coil itself. We did not experience any coil damage or unraveling. The detachment time was within normal limits when compared with regular GDC. A good packing of the aneurysm fundus was obtained in 19 cases. The giant internal carotid aneurysm was voluntarily under

packed to prevent flow impairment in the dominant carotid artery itself. There was no aneurysms rupture or perforation due to the Matrix. The 3-month control angiograms revealed a stability of the coiled aneurysms in all cases. No recanalization requiring further treatment was noted. The 6-month angiographic results are pending. No embolic complication occurred.

CONCLUSION

In spite of these being very preliminary results it seems that the Matrix coil is safe and feasible in the treatment of intracranial aneurysms. There is no major difference in the technique of deployment when compared with GDC coils. The preliminary results of the angiographic controls are very encouraging. In the case Neuroform stent was used in combination with the Matrix no problem was encountered. While we are awaiting the results of the 6-month angiogram follow-up, which will be available at the time of the ASNR Meeting in San Diego, we are under the impression that Matrix coil is safe and efficient in the treatment of intracranial aneurysm.

KEY WORDS: Aneurysm, coils

Poster 137

Experimental Model of Subarachnoid Hemorrhage for Combined Angiography/MR Research

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University of Wisconsin

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PURPOSE

To develop a canine model of hyperacute subarachnoid hemorrhage.

MATERIALS & METHODS

Under an approved animal subjects protocol, four anesthetized canines underwent MR imaging (T1, T2 FLAIR) followed by transfemoral catheterization of the basilar artery using an Excel Tracker 14 microcatheter. A baseline DSA was obtained of the vertebrobasilar system. The distal 19 cm of an Agility 14 guidewire was cut off to produce a relatively stiff distal segment capable of puncturing the arterial wall. Intravenous heparin (2000 units) was administered and under fluoroscopic guidance the guidewire was advanced 1 cm through the distal basilar artery wall. The DSA was repeated and the animals were returned to the MR scanner for imaging. Following the second MR exam the animals were euthanized and a limited necropsy performed.

RESULTS

The post puncture DSA images revealed immediate extravasation of contrast in three animals. One animal required intraarterial verapamil (3 mg) to relieve arterial spasm at the puncture site. SAH was confirmed in 3/4 animals by FLAIR imaging and by necropsy. In one animal there was no identifiable SAH on imaging and minimal SAH at necropsy.

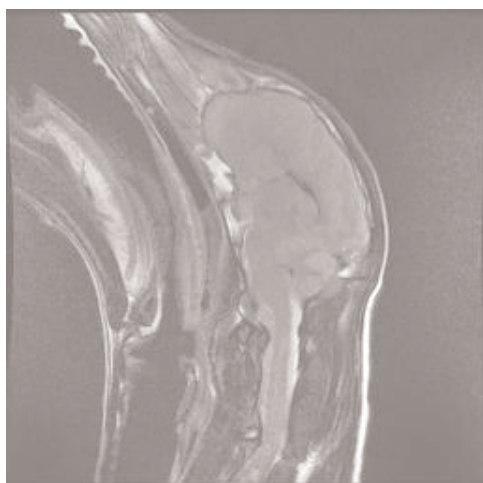


Figure: Sagittal FLAIR image following experimental subarachnoid hemorrhage. Note the high signal intensity ventral to the pons and surrounding the upper cervical cord.

CONCLUSION

Endovascular transarterial puncture of the basilar tip is a viable method to produce hyperacute SAH. Vasospasm following puncture may limit severely the volume of SAH. In general the size of the vascular structures and volume of SAH are suitable for XMR research.

KEY WORDS: Subarachnoid hemorrhage, experimental, MR imaging

Poster 138

Visualization of Sacral Nerve Roots via Percutaneous Intraspinal Navigation

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PURPOSE

Numerous conditions, including sacral neuralgia, pelvic floor dysfunction, and neurogenic bladder are related to sacral nerve root pathology. Surgical approach to these structures currently involves open surgery, including removal of varying amounts of spinal bone. A minimally invasive technique for visualizing the sacral nerve roots via percutaneous intraspinal navigation (PIN)(1) is described. This technique provides rapid, minimally invasive access to the sacral nerve roots and may enable both diagnostic and therapeutic approaches to these structures without bony removal.

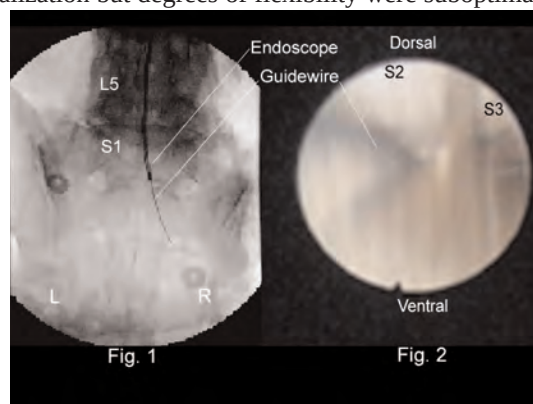
MATERIALS & METHODS

The head and spine were obtained in continuity from an embalmed male cadaver. The head and spine subsequently were encased in a low expansile foam. The model then was brought to our research angiography suite and placed in the prone position. A 7.5 F steerable endoscope was placed in the subarachnoid space and advanced caudally in the cadaveric model under both endoscopic and fluoroscopic guidance. Endoscopic images were captured using a digital frame storage apparatus. The endoscope was advanced into the ter-

minal thecal sac and nerve roots were imaged. Using the steerable feature of the endoscope, lateralization of visualization was enhanced.

RESULTS

Real-time endoscopic and digital radiographic images of the sacral nerve roots and bony relationships with the endoscope were obtained. Identification of the nerve roots was determined by both the spinal position of the endoscope and by placement of a 0.035" guidewire through the foramen through which the nerve root exited (Figure 1 - endoscope at right S2 root with a guidewire traversing through the right S2 foramen). The nerve roots were visualized both as they coursed caudally and as they exited the thecal sac (Figure 2 - endoscopic image of the right S2 root exiting the thecal sac). By placement of the endoscope in the terminal thecal sac, the S4, S5, and coccygeal nerves could be identified bilaterally as well. Steerability of the endoscope was found to enhance visualization but degrees of flexibility were suboptimal.



CONCLUSION

Accessing the sacral nerve roots via the PIN technique is technically feasible and straightforward. Using a combination of fluoroscopy and endoscopy, nerve roots can be seen and identified. This approach thus may offer an alternative to open surgical exposure for either diagnostic or therapeutic purposes. Technical developments including greater endoscope flexibility and control and devices for use via the working lumen are needed. Safety and efficacy also must be established.

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KEY WORDS: Percutaneous intraspinal navigation (PIN), sacral nerve roots, endoscopy

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of a 7.5 French flexible ureteroscope made by Karl Storz Endoscopy America Inc. for endoscopy of the spinal cord.

The authors of this work have indicated the following affiliations/disclosures: Boston Scientific: Licensing agreement for the percutaneous intraspinal navigation technique.

Poster 139

Visualization of the Posterior Inferior Cerebellar Artery via Percutaneous Intraspinal Navigation

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PURPOSE

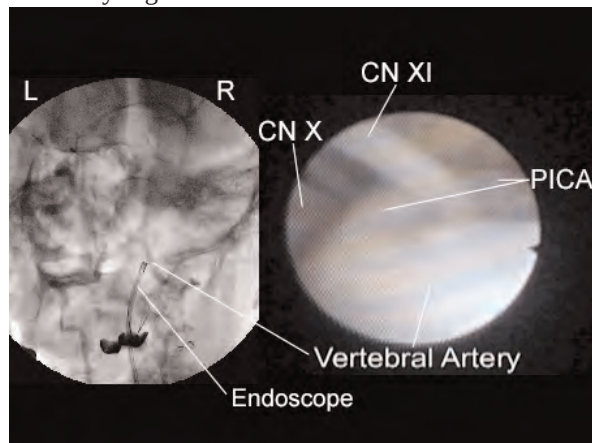
A percutaneous approach to the cerebral subarachnoid space from a lumbar puncture has been described previously (1). Use of this approach for subarachnoid surgery requires detailed knowledge of the appearances of different anatomical structures. The purpose of this study is to determine whether percutaneous intraspinal navigation (PIN) can be used to visualize the posterior inferior cerebellar artery (PICA) and to define its appearance using a combination of a small-caliber endoscope and fluoroscopy. Since this technique provides rapid access to the cisterna magna and its anatomical structures without the need for open surgical exposure, minimization of iatrogenic trauma might be feasible if clinical use were enabled.

MATERIALS & METHODS

An embalmed male cadaveric head and neck was obtained. X-ray and MR compatible fiducial markers were affixed to the head. The head subsequently was encased in a low expansile rigid foam. The model was brought to our research angiography suite and placed in the prone position. A 7.5 F steerable endoscope was placed in the subarachnoid space and positioned ventro-lateral to the spinal cord and advanced cranially in the cadaveric head and neck model under X-ray fluoroscopy. Endoscopic images were stored using a direct digital capture apparatus.

RESULTS

Realtime endoscopic and X-ray fluoroscopic images of PICA were obtained. Endoscope position relative to the vertebrobasilar system was confirmed with contrast injection in the ipsilateral vertebral artery (Figure 1). The vertebral artery was identified endoscopically and followed both to the vertebrobasilar junction and to the origin of PICA (Figure 2). PICA and its course laterally were visualized as the endoscope was advanced. The vagus and spinal accessory nerves also were visualized and photographed. From the anterior spinal subarachnoid space, PICA could be seen into its lateral medullary segment.



CONCLUSION

Accessing the cisterna magna and its anatomical structures via the PIN technique is both technically feasible and straightforward. PICA can be seen to its lateral medullary segment using currently available fiberoptic endoscopes. Improvements in endoscope technology may enable further visualization. This approach may offer a potential alternative to open surgical exposure if further study confirms safety and efficacy for specific applications.

REFERENCES

1. Purdy PD, Replogle RE, Pride GL Jr, Adams C, Miller S, Samson D. **Percutaneous Intraspinal Navigation (PIN): A Feasibility Study in Cadavers of a New and Minimally Invasive Approach to the Spinal Cord and Brain.** *AJNR Am J Neuroradiol* 2003;24:361-365

KEY WORDS: Percutaneous intraspinal navigation, vertebrobasilar, endoscopy

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of a 7.5 French flexible ureteroscope made by Karl Storz Endoscopy America Inc. for endoscopy of the subarachnoid space.

The authors of this work have indicated the following affiliations/disclosures: Boston Scientific/Target Corporation: Licensing agreement of the percutaneous intraspinal navigation technique.

Poster 140

Intracranial Angioplasty for Symptomatic Middle Cerebral Artery Stenosis: Experience in 33 Patients

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Gwangju, REPUBLIC OF KOREA

PURPOSE

To report our 9-year experience with percutaneous transluminal angioplasty for symptomatic middle cerebral artery stenosis.

MATERIALS & METHODS

Thirty-three consecutive patients (mean age, 56 years) with symptomatic middle cerebral artery stenosis underwent intracranial balloon angioplasty from June 1994 to June 2003. The indication for angioplasty was recurrent transient ischemic attack in 23 patients and acute ischemic stroke in 10 patients. All patients had high grade stenosis more than 70% in the middle cerebral artery.

RESULTS

Angioplasty was effective in reducing the degree of stenosis less than 50% in 30 patients (91%). Minimal asymptomatic dissection was identified on angiographic studies obtained just after angioplasty in seven (21%). Transient neurologic complications that cleared within 24 hours after angioplasty occurred in 6 patients (18.2%). One vascular rupture during balloon dilation resulted in intracranial hemorrhage and

death. The risk of disabling stroke or death was 6.1% (2 of 33). Of the 23 patients with transient ischemic attack, no one experienced further transient ischemic attack except one who had acute ischemic stroke 6 months after angioplasty. Of the 10 patients with acute ischemic stroke, nine patients improved clinically after angioplasty and no one had further ischemic symptoms during follow-up period. Seven patients were followed up with angiography for at least 15 months, and none showed restenosis.

CONCLUSION

Intracranial angioplasty for symptomatic middle cerebral artery stenosis is safe and effective in the management of both transient ischemic attack and acute ischemic stroke.

KEY WORDS: Middle cerebral artery stenosis

Poster 141

Diffusion-Weighted MR Imaging Abnormalities after PTA/Stenting for Intracranial Atherosclerotic Disease

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PURPOSE

We evaluated the frequency of thromboembolic events after PTA/stenting for intracranial atherosclerotic disease, by using diffusion-weighted MR imaging.

MATERIALS & METHODS

Sixteen patients with symptomatic stenosis greater than 60% of the intracranial artery were treated with PTA (5 cases) and/or stent placement (11 cases) between January 1995 and April 2003. Before and after intervention, whole brain diffusion-weighted imaging (DWI) was acquired. According to the characteristics of new hyperintensities, all cases were divided into the following three groups: type A, no new hyperintensities; type B, single spot only; type C, multiple spots.

RESULTS

We detected 8 type A, 6 type B, and 3 type C lesions. All hyperintense lesions were less than 5 mm in diameter. In stent group, hyperintense lesions were detected in eight of 11 patients. In MCA group treated with PTA only, single spot lesion was detected after the procedure.

CONCLUSION

In PTA/stenting for intracranial atherosclerotic disease, the chance to cause massive thromboembolic stroke detected on DWI is rare. From the viewpoints of embolic complication, PTA/stenting for intracranial atherosclerotic disease is safer than carotid artery stenting.

KEY WORDS: PTA/stenting, diffusion-weighted MR imaging, atherosclerosis

Poster 142

Usefulness of Percutaneous Transluminal Angioplasty for Acute Middle Cerebral Artery Embolism

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PURPOSE

Acute middle cerebral artery embolism (MCAE) has been treated by intraarterial fibrinolysis (LIF), but not all cases showed recanalization and good outcome. In patients with MCAE, the embolus was often so large as to be resistant to fibrinolysis, and time-consuming fibrinolytic therapy with high doses of urokinase may be required, which may result in hemorrhagic complication. As an alternative option to LIF, percutaneous transluminal angioplasty (PTA) using a single lumen balloon catheter (STEALTH) with a valve wire has been performed to treat acute MCAE. However, we found use of STEALTH with a valve wire could be associated with poor maneuverability of a valve wire in some cases with tortuous access route, which may lead to unsuccessful procedure. The purpose of this study was to evaluate the safety and efficacy of a modified PTA technique using STEALTH with a nonvalve wire for acute MCAE.

MATERIALS & METHODS

Twenty-seven patients (15 men and 12 women; mean age, 68.2 years) had acute MCAE. Seven of 27 patients were treated with a modified PTA technique. STEALTH was advanced into the occlusion site with 0.016 inch microguidewire (nonvalve wire). Percutaneous transluminal angioplasty was performed with inflation of balloon with the same guidewire at 2 to 4 atm for 30-60 seconds. Intraarterial fibrinolysis was added when distal emboli was observed. Follow-up CT was performed within 24 hours and 3-7 days after onset. Rates of recanalization, complications, and clinical outcome assessed by Glasgow outcome scale (GOS) were evaluated with comparison of control group of patients treated with standard PTA (n = 7) and LIF alone (n = 13).

RESULTS

Modified PTA had a higher recanalization ratio (100%), than standard PTA (28.6%) and LIF alone (53.8%). In 5 of 7 patients, standard PTA failed because the valve wire into the balloon catheter could not pass through the tortuous access route. However, modified PTA did not improve the rate of independent lifestyle (57%, 14%, 54% in modified PTA, standard PTA, LIF alone, respectively). Symptomatic large hemorrhages occurred in 3 patients (2 in LIF group, 1 in modified PTA group).

CONCLUSION

A modified PTA technique showed the high rate of recanalization, and may be a safe and effective treatment for acute MCAE.

KEY WORDS: Middle cerebral artery embolism, percutaneous transluminal angioplasty, fibrinolysis

Poster 143**MR Venogram of Sinus Thrombosis: When Is Endovascular Intervention Required?**

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PURPOSE

To present the key features seen on MR venogram and MR imaging of the head that would indicate the need for urgent endovascular intervention (thrombectomy, thrombolysis) in patients with sinus thrombosis.

MATERIALS & METHODS

Ten consecutive patients with sinus thrombosis were evaluated by MR venogram [2D time-of-flight (TOF) with maximum intensity projection reconstruction] along with MR imaging of the brain. The above were performed on a standard 1.5 T MR scanner. The findings were correlated with catheter angiography, and subsequent endovascular intervention. Common features found on the MR venogram and MR imaging of the brain that helps to determine the need for endovascular intervention was analyzed to assess significance. Normal anatomical variation also was discussed, along with potential pitfalls.

RESULTS

Sinus thrombosis usually is identified on MR venogram as a segmental area of absent flow, with presence of collaterals in the region. Paucity of collaterals and/or absence of a venous outflow on the involved side are significant. Presence of T1-shortening material within the sinus signifies thrombus formation as the immediate underlying cause. Brain edema, infarction, and/or hemorrhage in the territory drained by the thrombosed sinus usually predicate a restricted venous outflow, and need for urgent intervention. Lack of the above insult may simply suggest a sufficient collateral system. But, the urgent need for clot removal and reestablishment of venous outflow is still present, especially in symptomatic patients, so that the later sequela of dural arteriovenous fistula can be avoided.

CONCLUSION

Standard 2D TOF MR venogram usually is performed initially to evaluate patients with clinical suspicion of sinus thrombosis. The urgent need and indication for endovascular intervention is dependent on the interpretation of this study. Understanding the key features of sinus thrombosis on MR venogram and MR imaging of the brain is crucial for appropriate patient management.

KEY WORDS: MR venography, sinus thrombosis

Poster 144**Clinical Results of Angioplasty and Stenting for Intracranial Extradural Internal Carotid Stenoses**

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¹Minami-Wakayama National Hospital, Tanabe City, JAPAN, ²Wakayama Medical University, Wakayama City, JAPAN

PURPOSE

Recently, medically refractory intracranial atherosclerotic stenosis has been treated by angioplasty and stenting. We report clinical results and problems of angioplasty or stenting for intracranial extradural internal carotid artery (ICA) stenoses.

MATERIALS & METHODS

Total 51 cases (51 lesions) of intracranial extradural internal carotid artery stenoses were treated by angioplasty or stenting under local anesthesia. In 27 lesions located in petrous portion of ICA, 11 and 16 lesions were treated angioplasty alone and stenting, respectively. In 24 lesions of cavernous portion, we performed angioplasty in 9 lesions and stenting in 15 lesions. All lesions have stenotic rate above 60%.

RESULTS

Technical success rate was 98%. In 26 cases of angioplasty alone, 69.8% of average stenotic rate reduced to 25.6% after angioplasty, while 74.2% of average stenotic rate remarkably decreased to 5.7% in 24 cases of stenting. In patients with petrous ICA stenosis, average stenotic rate improved from 74.7% to 9.9%. On the other hand, average stenotic rate of cavernous ICA lesion showed 68.7% before and 23.3% after angioplasty or stenting. Morbidity rate within 30 days after the procedures, rate of neurologic deficits which continue over 30 days and mortality rate was 6%, 2%, and 0%, respectively. As a morbidity, TIA due to air embolism during the procedure occurred in one case and carotid cavernous fistulas due to ICA laceration, which required coil embolization later, showed transient oculomotor and abducens nerve palsies in one case. In one case of permanent neurologic deficit, stent thrombosis occurred 2 days after the intervention and thrombolysis was required. In 2 of 45 patients (4.4%), restenosis (> 50% stenotic rate) was detected.

CONCLUSION

Angioplasty or stenting for intracranial extradural internal carotid artery stenoses demonstrated low morbidity, low mortality, and high technical success rate. Long-term follow-up may be necessary to detect restenosis, especially in cases of ICA stenosis in cavernous portion, which tend to result in poor improvement of stenotic rate probably because two thirds of the patients underwent angioplasty alone.

KEY WORDS: Intracranial internal carotid stenosis, angioplasty, stent

Poster 145**Effect of Distal Balloon Protection Technique for Carotid Stenting: Analysis from Consecutive 200 Cases**

Terada, T. • Tsumoto, T. • Yamaga, H. • Itakura, T.

Wakayama Medical University
Wakayama, JAPAN**PURPOSE**

The effect of distal balloon protection technique for carotid stenting was examined.

MATERIALS & METHODS

Two hundred carotid stenosis greater than 60% were treated by carotid stenting under distal balloon protection technique. Initial 38 cases were treated balloon protection only at the postdilatation period. Next 78 cases were protected at the period predilatation and postdilatation using naviballoon. Recent 84 cases were treated at the period of predilatation, stenting, and postdilatation using PercuSurge. Clinical outcome was evaluated in all cases and the effect of distal balloon protection was examined.

RESULTS

One minor stroke appeared after carotid stenting in initial 38 cases. One minor stroke, one hyperperfusion syndrome resulted in minor stroke and one nonstroke death were encountered after stenting in 78 cases. One case with acute stent thrombosis, which was recanalized immediately, resulted in minor stroke in 84 PercuSurge cases. The ischemic complication was 1.5% and overall morbid/mortality rate was 2.5% in consecutive 200 cases treated with distal balloon protection technique.

CONCLUSION

Distal balloon protection technique is effective to prevent embolic stroke during carotid stenting.

KEY WORDS: Carotid stenting, protection device, clinical outcome

Poster 146**Is There a Difference in Clinical Outcome in Recanalizations Involving the Superior Division vs the Inferior Division of the Middle Cerebral Artery?**

Christoforidis, G. A. • Mohammad, Y. • Slivka, A. • Slone, H. W. • Bourekas, E. • Chakeres, D. W.

The Ohio State University
Columbus, OH**PURPOSE**

To determine whether clinical outcomes from intraarterial thrombolysis for ischemic stroke involving the middle cerebral artery (MCA) differ depending on whether there is recanalization of the inferior vs the superior division of the MCA.

MATERIALS & METHODS

Angiograms, and National Institutes of Health Stroke Scale (NIHSS) scores at the time of discharge from the hospital were reviewed retrospectively in 55 patients who underwent

intraarterial thrombolysis for acute ischemic stroke involving the middle cerebral artery. Site of occlusion, and result of thrombolysis (no recanalization, recanalization of the superior division only, recanalization of the inferior division only, or complete recanalization) were recorded also from angiograms. Analysis of variance assuming that NIHSS score is a continuous variable then was used to determine whether there was a significant difference between the groups.

RESULTS

Median discharge NIHSS scores for those patients who had no recanalization was 16.5 (range 7-42; n = 14); for those with recanalization of the inferior division only it was 10.5 (range 7-42; n = 14); for those with recanalization of the superior division only it was 7.5 (range 3-15; n = 4) and for those with complete recanalization it was 3 (range 0 - 22; n = 23). Analysis of variance indicated that there is a statistically significant difference among the recanalization groups examined (p = 0.0003). There was a tendency for patients with recanalization of the superior division only to have better outcomes than those with recanalization of the inferior division only.

CONCLUSION

When there is recanalization within only one division of the middle cerebral artery following intraarterial thrombolysis, recanalization of the superior division branch of the MCA tends to lead to better immediate clinical outcomes relative to those patients who have recanalization of the inferior division of the middle cerebral artery.

KEY WORDS: Thrombolysis, angiography, stroke

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of r-tpa made by Genentech for intraarterial thrombolysis.

Poster 147**Symptomatic Posterior Circulation Stenosis: Endovascular Treatment with Stents**Miranda, C.^{1,2,3} • Lylyk, P.¹ • Rufenacht, D.² • Ferrario, A.¹ • Romero, R.¹ • Vila, J.¹ • Pabon, B.¹¹ENERI, Buenos Aires, ARGENTINA, ²Clínica Médica Belgrano, Buenos Aires, ARGENTINA, ³University of Geneva, Geneva, SWITZERLAND**PURPOSE**

To determine the clinical and angiographic outcome of patients with symptomatic intracranial atherosclerosis who fail antithrombotic therapy in which an endovascular treatment was performed with the stent implantation.

MATERIALS & METHODS

Between June 1996 and May 2003, symptomatic patients with posterior circulation intracranial stenosis in spite of better medical treatment were selected to be treated with intracranial stents. Clinical syndromes were registered, the angiographic stenosis features and occlusion rates were classified according Mori score in three groups A,B,C. Clinical benefits were evaluated in short time and during the follow-up. Restenosis or thrombosis in stent were documented.

RESULTS

From 90 intracranial stenosis, 52 (57.7 %) were in the posterior circulation. The location was: vertebral 20 (38.5%), basilar 15 (28.8 %), vertebro-basilar junction 13 (25%) and P1 4 (7.7 %). The mean stenosis rate was 72.4 %. One stent was implanted in 31 patients (59.6%), two or more stents were deployment in 21 cases. Respect to clinical results, 67% improved its symptoms, 26.5% remain stable, and 6.5% revealed poor clinical evolution. In all cases, the stenosis grade was overall reduced to less than 30%. Clinical follow-up was obtained in all patients. Angiographic follow-up was possible in 33 (63.4%). The restenosis rate was 12.5% and reangioplasty was necessary in 2 cases.

CONCLUSION

The goal of all cerebrovascular interventions is to alleviate symptoms and prevent complications. Currently, the intravascular stents use for treatment intracranial stenosis has been implemented. Such new approach is feasible and safe. Posterior studies are being undertaken to evaluate the potential role of this therapy in intracranial atherosclerotic disease and expand the field of interventional neuroradiology.

KEY WORDS: Intracranial stenosis, stents, stroke

Poster 148

Blood Flow Improvement through Critical Stenoses during Intracranial Angioplasty Procedures with Adjunctive Abciximab Increases Procedural Safety

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PURPOSE

To describe the outcomes of patients administered abciximab prior to neurointerventional angioplasty in an attempt to enhance lumen visualization, significantly increasing the safety and feasibility of the procedure.

MATERIALS & METHODS

Case 1. A 68-year-old patient presented with a several-month history of worsening dizziness and vertigo episodes lasting 10-20 minutes. The patient reported a 10-year history of hypertension with a negative cardiac evaluation. Emergency cerebral angiography confirmed the total occlusion of both intracranial vertebral arteries (Figure a). Abciximab (Centocor, Malvern, PA) was administered preangioplasty as a weight-based bolus dose (0.25 mg/kg) to prevent downstream distal embolization typically heightened by mechanical intervention. Angiography at 55 minutes demonstrated anterograde flow to the basilar artery from the left vertebral artery prior to any percutaneous intervention (Figure b). Angioplasty of the left intracranial vertebral artery for near complete occlusive stenosis was successfully completed. Follow-up angiogram demonstrated significant cerebral flow improvement as compared to the preprocedure angiogram. **Case 2.** A 60-year-old patient presented with tinnitus, vertigo, diplopia, and left ear pressure. Conventional cerebral angiography demonstrated an occlusion of the right vertebral artery and critical stenosis (99%) of the left intracranial vertebral artery with minimal blood flow to the basilar artery.

Weight-based (0.25 mg/kg) bolus dose of abciximab was administered. Significant preintervention increases in cerebral flow were observed while simultaneously facilitating guide wire access and intervention. Balloon angioplasty of the left intracranial vertebral artery was performed improving posterior circulation.

RESULTS

Abciximab has been shown to be an effective adjunct therapy for the treatment of thromboembolic complications associated with neurointerventional procedures (1). Prophylactic administration appears to enhance artery recanalization, improve perfusion, and facilitate mechanical intervention while possibly preventing and/or alleviating downstream distal embolization. These case reports appear to demonstrate the beneficial effects of abciximab and its ability to disaggregate platelet-derived thrombus.

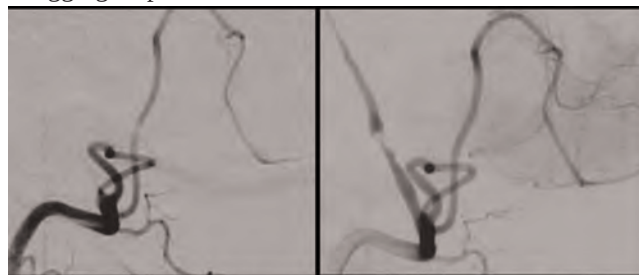


Fig a. Total occlusion of the left vertebral artery

Fig b. Post abciximab administration (pre-angioplasty). Lumen of the left vertebral artery and basilar artery are now visualized.

CONCLUSION

The adjunctive use of abciximab therapy during neurointerventional procedures appears to be a viable alternative to thrombolytic treatment. The "fibrinolytic-like" properties of abciximab appear to disaggregate platelet thrombi and increase cerebral artery perfusion while simultaneously facilitating the use of catheter guide wires.

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KEY WORDS: Abciximab, angioplasty, safety

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of abciximab made by Centocor for neurointerventional use.

Pediatrics
149-168

Poster 149

Application of Transcranial Doppler in Children with Acute Neurologic Events Due to Cerebral Vasculitis

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PURPOSE

The purpose of this study is to determine if transcranial Doppler (TCD) could be applied to evaluate cerebrovascular disease in children with acute stroke due to cerebral vasculitis.

MATERIALS & METHODS

A retrospective review was performed in 3 girls (ages 8, 9, and 13 years) with acute stroke due to cerebral vasculitis, all of whom underwent TCD, MR imaging and catheter angiography. Periodic follow-up with each imaging modality was performed (range 6 months to 2.5 years). Correlation of findings on TCD was compared to MR imaging and catheter angiography.

RESULTS

In all 3 girls, acute strokes occurred in the left middle cerebral artery distribution. Transcranial Doppler was significantly abnormal in the distribution of the acute stroke, where MR imaging and catheter angiography demonstrated vascular stenoses, beading, and irregularity. Peak systolic velocities were highest acutely at 340, 191, and 260 cm/sec. A gradual return to normal velocities (< 120 cm/sec) was observed on TCD over several months in 2 girls, which correlated with eventual return to normal on MR imaging and catheter angiography. In the last girl, gradual improvement has occurred at 6-month follow-up (peak systolic velocity < 180 cm/sec) with continued follow-up ongoing. Vasculitis was idiopathic in the first 2 girls and due to West Nile virus in the last girl.

CONCLUSION

Transcranial Doppler may become a valuable adjunct to MR imaging and catheter angiography allowing for frequent evaluation of cerebrovascular velocities during acute and follow-up stages of cerebral vasculitis complicated by stroke.

KEY WORDS: Vasculitis, stroke, transcranial Doppler

Poster 150

Age-Dependence of Diffusion-Weighted MR Findings in Maple Syrup Urine Disease Encephalopathy

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PURPOSE

In classical form of maple syrup urine disease (MSUD), neurologic function may deteriorate rapidly at any age due to metabolic intoxication provoked by common infection and injury. Diffusion-weighted imaging (DWI) studies have been shown more sensitive than conventional MR imaging in detecting brain alterations in MSUD encephalopathy and may serve as a useful tool for early diagnosis and follow-up. It has been suggested that the apparent diffusion coefficient (ADC) decreases in myelinated areas due to intramyelinic edema and increases in unmyelinated areas due to vasogenic, interstitial edema. Therefore, as myelination progress, ADC and DWI findings in MSUD encephalopathy are considered to change. We report MR imaging findings of a patient with classical form of MSUD who developed encephalopathy in the neonate and older infancy. The purpose of this presentation is to illustrate the age-dependence of DWI findings in MSUD encephalopathy.

MATERIALS & METHODS

A female patient diagnosed as classical form of MSUD underwent MR imaging studies on a 1.5 T unit (Signa Horizon LX, General Electric Medical Systems) during two episodes of encephalopathy and the interval period. Diffusion-weighted imaging was performed using the following parameters: FOV, 22 x 20; matrix, 128 x 128; b factor, 0-1000 s²/mm. The ADC value was calculated on a pixel-by-pixel basis with a dedicated workstation (Advantage Windows, General Electric Medical Systems).

RESULTS

At 11 days of age, she developed MSUD encephalopathy and underwent MR imaging. T2-weighted images showed generalized cerebral swelling and sulcal effacement with diffuse hyperintensity in most of the white matter (WM). High intensity on DWI was observed in cerebellar WM, cerebral peduncles, thalami, the posterior limbs of the internal capsules, and the central portions of the centrum semiovale. The ADC values in these areas were markedly low compared with normal. Follow-up studies were almost normal. At 18 months of age, she developed MSUD encephalopathy again. MR T2-weighted images showed diffuse hyperintensity in cerebral WM, globi pallidi, thalami, midbrain, and brain stem. High intensity areas on DWI were more extensive than in the first episode, and symmetric high signal was noted in cerebellar WM, brainstem, globi pallidi, the posterior limb of the internal capsule, the dorsomedial nucleus of thalami, corpus callosum, and most of cerebral WM. The estimated ADC was decreased in comparison with that on the study performed during the interval period. The differences in DWI findings between the two episodes were considered to be attributable to progress of myelination. Intramyelinic edema occurs in the white matter where the myelin matured. We speculated that according to the maturation of

myelin, the areas of the restricted diffusion and the ADC decrease spread in MSUD encephalopathy. After intensive treatment, she achieved normal neurologic development despite the difficult infantile course.

CONCLUSION

The patient described here indicates age-dependent changes in DWI findings in MSUD encephalopathy, which appears ascribable to progress of myelination. Diffusion-weighted imaging sensitively detects abnormalities associated with MSUD and may contribute to early diagnosis of MSUD encephalopathy and, consequently, appropriate patient management.

KEY WORDS: Maple syrup urine disease, diffusion-weighted MR imaging, metabolic

Poster 151

Imaging, DTI, and Spectroscopy in Incontinentia Pigmenti (Bloch-Sulzberger Syndrome)

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PURPOSE

Incontinentia pigmenti (Bloch-Sulzberger Syndrome) is a rare, x-linked, dominant neurocutaneous illness (w:m = 37:1). There are only few reports about accompanying changes in central nervous system (CNS) in particular using spectroscopic and DTI imaging techniques. The typical signs and symptoms are described, also results of the spectroscopy in the course of the illness.

MATERIALS & METHODS

A 3.5-year-old girl with typical cutaneous signs of incontinentia pigmenta including microphthalmia came to our examinations. In the beginning, the little patient additionally had epileptic seizures.

RESULTS

The neuroradiologic examinations with MR revealed, according to the literature, changes of the white matter, a left hemispheric delay of development with enlargement of the lateral ventricle, and a dysplasia of the corpus callosum with missing rostrum. Spectroscopy in a region, suspected to be the origin of the seizures out of EEG data, showed a lactate-peak (seizures were noted in the days before). The NAA/creatinine quotient was reduced compared to the normal-appearing right side (1.47 to 1.74). A control examination with MR imaging after 1 year showed a normalization of the lactate measurements with effective antiepileptic drug therapy and missing seizures, the NAA reduction did not change. The DTI images including anisotropy indices showed a considerable reduction of the white matter tracts, the pyramidal tract was demonstrable with the fiber-tracking technique, but with a significant reduction of the number of tracts.

CONCLUSION

The morphologic changes found in our patient is according to the literature and forms a pattern. The DTI measurements showed a reduced anisotropy of the parts of the brain concerned corresponding to the reduction of NAA. The lactate peak found in the first examination in the course of our patient fits well with findings in other patients with focal epilepsies as transient changes as a consequence of seizures.

KEY WORDS: Incontinentia pigmenti, DTI, spectroscopy

Poster 152

Familial Erythrophagocytic Lymphohistiocytosis: Diffusion Imaging Findings and Review of Literature

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PURPOSE

To present the diffusion-weighted imaging (DWI) findings in two patients with familial erythrophagocytic lymphohistiocytosis (FEL) and to review the imaging findings and pathology.

MATERIALS & METHODS

Two patients with bone-marrow biopsy proven diagnosis underwent multiple imaging studies including CT and MR imaging with DWI. The literature was reviewed for both the neuroradiologic findings and the pathophysiology.

RESULTS

Familial erythrophagocytic lymphohistiocytosis is a rare disease resulting from the abnormal proliferation and infiltration of histiocytes in tissues and organs but with no malignancy. Treatment consists mainly of chemotherapy and bone-marrow transplantation. The first patient, a 16-month-old girl with seizures showed diffuse restricted diffusion in the cerebral cortex and basal ganglia sparing the cerebral white matter and cerebellum on DW MR imaging. Standard MR sequences showed diffuse increased T2 with reduced T1 signal in the cerebral white matter and cerebellum, with increased T1 and T2 signal in the basal ganglia, and post-contrast enhancement in the putamina. Bilateral subdural collections also were present. The MR findings were not suggestive of acute ischemia. The patient had recent myeloablation for bone-marrow transplantation. An extensive search of the radiologic literature revealed no reports of similar DWI changes in FEL.

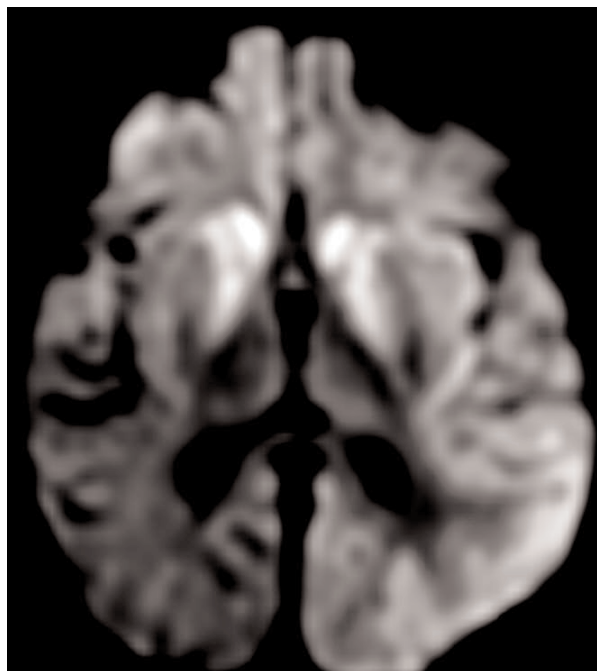


Figure: DWI in patient 1

The second patient, an 11-year-old girl, with a history of seizures had no restricted diffusion on DW MR imaging. The standard MR sequences showed volume loss with diffuse bilateral cerebral white matter and cerebellar hyperintense T2 signal which improved with therapy. The areas of enhancement seen on the older scans had resolved. The MR imaging was typical of the disease described in literature.

CONCLUSION

The above DWI findings in FEL are unreported previously. The typical abnormalities on the standard sequences have been explained on the basis of lymphocytic and histiocytic infiltration in the perivascular spaces and the brain substance itself with resulting demyelination, astrogliosis, necrosis, and cavitation. The cause for the discordant imaging findings in our two cases is unclear. It is believed at this time that the findings in patient 1 were due to an acute diffuse infiltrative process with possible resulting demyelination change. The clinical picture did not favour diffuse infection. Diffusion-weighted imaging may be a useful tool to differentiate the diffuse acute infiltrative manifestation of FEL from its usual nonspecific appearance.

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KEY WORDS: Familial erythrophagocytic lymphohistiocytosis, diffusion-weighted imaging, subdural collections

Poster 153

Unusual Diffusion-Weighted Imaging Findings Along with Unusual Clinical Presentations in Juvenile Metachromatic Leukodystrophy

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PURPOSE

To display unusual diffusion-weighted imaging (DWI) findings along with unusual clinical presentations in 3 children with juvenile type metachromatic leukodystrophy (MLD).

MATERIALS & METHODS

All 3 cases were diagnosed as MLD by decreased serum activity of enzyme arylsulfatase A. Case1 (9-year-old boy) and case 2 (6-year-old girl) are 2 siblings of the same family. Case 3 is a 6.5-year-old girl. Diffusion-weighted imaging and conventional MR imaging findings were evaluated for each case.

RESULTS

Two siblings (cases 1 and 2) were healthy until the age of 5 at which a recurrent, episodic abdominal pain started. The same pattern of the abdominal pain also was present in the father who was healthy otherwise. Then the children developed clumsy gait, intellectual deterioration, muscular weakness and elder child was in poorer clinical condition. T2-weighted images showed bilateral increased intensity of the centrum semiovale and peritrigonal white matter in both cases. On DWI of the elder sibling, there were symmetric bilateral lines of low ADC value between inner and outer areas of increased ADC values. In younger sibling, there was a thin line of restricted diffusion in the corpus callosum and in the deep white matter, on DWI. Also some of these lines corresponded to the border zone between demyelinated white matter and normal white matter. Case 3 is a previously healthy 6.5 year old, admitted with diplopia, headache, and vertigo while she was being followed up with a diagnosis of MLD for 1 year. She became unconscious in 12 hours, developed anisocoria with no light reflex on the left side. Cranial MR imaging displayed the pons, red nuclei, and pyramidal tract in the mesencephalon had increased T2 signal intensity and intense contrast enhancement. On DWI, restricted diffusion in the red nuclei and in the white matter not in the deepest, but mostly in the more peripheral areas, some in the marginal site between affected and unaffected white matter. Six weeks later she returned to her baseline clinically and next MR imaging obtained 5 months after her first episode revealed new T2 signal hyperintensities in the right thalamus, posterior limb of the internal capsule, and basal ganglia region. After contrast there was enhancement of posterior limb of the internal capsule on the right. Bilateral red nuclei abnormality observed in previous MR imaging had disappeared, but a unilateral swelling and T2 hyperintensity localized to the right cerebral peduncle appeared that time. There was no evidence of reduced ADC on these new lesions, but in a limited area of anterior periventricular white matter. These recently formed lesions had disappeared again when she could walk with help and talk slowly and had mild left hemiparesis, a coarse tremor, more evident on the left arm.

CONCLUSION

Juvenile type of MLD may present with unusual clinical pictures such as recurrent abdominal pain and episodic events in addition to classical symptoms of MLD. Thin segmental lines of restricted diffusion may represent a histologic stage between intracellular sulfatide accumulation and myelin breakdown in this particular disease.

KEY WORDS: Metachromatic leukodystrophy, MR imaging, diffusion-weighted imaging

Poster 154

MR Imaging of the Fetal Cerebellar Vermis In Utero: Description of Some Useful Anatomical Criteria for Normal Development

Robinson, A. J.¹ • Blaser, S.¹ • Toi, A.² • Chitayat, D.² • Ryan, G.² • Pantazi, S.² • Gundogan, M.² • Laughlin, S.¹

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PURPOSE

To define and produce an atlas of easily identifiable and reproducible measurements and markers of normal anatomical development of the fetal cerebellar vermis in vivo. Virtually all previous studies of development of the cerebellum have been performed on fetal specimens, and few in vivo studies discuss development of the cerebellar vermis per se.

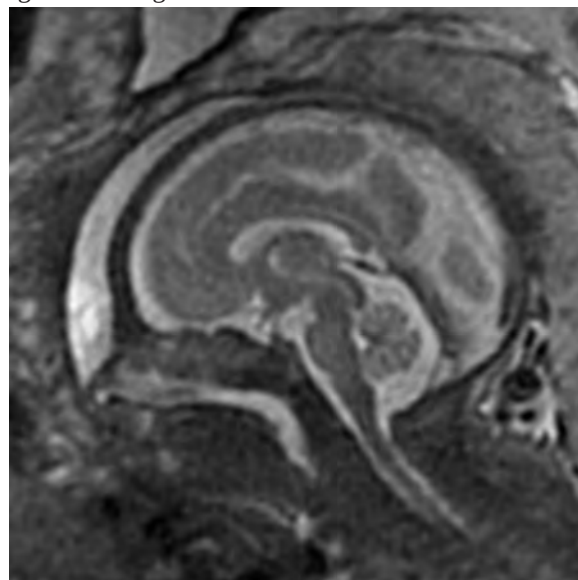
MATERIALS & METHODS

Retrospective analysis of the midline sagittal views of the cerebellar vermis was performed in over 130 consecutive fetal MR examinations performed for CNS and non-CNS indications. Analysis included identification of the fastigial point and vermian fissures, degree of coverage of the fourth ventricle, cerebellar growth and proportions, tegmento-vermian angle, and associated abnormalities of the posterior fossa, brainstem, and CNS. Fetuses imaged for the specific assessment of abnormalities affecting the posterior fossa were evaluated separately.

RESULTS

Gestational age ranged from 14.9 to 38.6 weeks with a mean of 26.6 weeks. Useful midline sagittal views were obtained in over 100 studies, with a total of over 230 measurements. Average craniocaudal diameter of the cerebellar vermis follows growth approximately predicted by the linear equation: diameter (mm) = 0.73 x gestational age (weeks) - 5.62, with an R² value of 0.91. Average height above and below the fastigial point also followed a linear progression, with average percentages above and below of 48.5% and 51.5% respectively, and no significant change of this ratio with gestational age. The tegmento-vermian angle was always < 2° in normal fetuses, but was often increased in abnormal fetuses. Coverage of the 4th ventricle should usually have occurred by 17-18 weeks. The declive and primary fissure always were visible in normal fetuses from 17.5 weeks. The other cerebellar vermian fissures were seen at approximately the following gestational ages: secondary (postpyramidal) at 20 weeks, prepyramidal at 21 weeks, and preculmenate at 22 weeks. The other lobules (besides declive) became visible from 24 weeks and most were visible by 27 weeks.

Exceptions were noted among those fetuses being investigated for posterior fossa abnormalities. Correlation with in vitro studies shows a delay of approximately 3-5 weeks in the gestational age at which these features are seen.

**CONCLUSION**

Useful anatomical landmarks included identification of the fastigial point, presence of the fissures, vermian growth and proportions, and tegmento-vermian angle. An atlas of these features of normal development is demonstrated.

Part 1 of 2. See abstract 973 for part 2.

KEY WORDS: Vermis, fetal MR imaging, Dandy-Walker

Poster 154A

MR Imaging of the Fetal Cerebellar Vermis In Utero: Criteria for Abnormal Development, with Ultrasonographic and Clinicopathologic Correlation

Robinson, A. J.¹ • Blaser, S.¹ • Toi, A.² • Chitayat, D.² • Ryan, G.² • Pantazi, S.² • Gundogan, M.² • Laughlin, S.¹

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PURPOSE

Our previous study produced an atlas of easily identifiable and reproducible measurements and markers of *normal* anatomical development of the fetal cerebellar vermis in vivo from 17.5 weeks gestational age to term. This study is to demonstrate easily identifiable and reproducible measurements and markers of *abnormal* development, with ultrasonographic and clinicopathologic correlation where available. Virtually all previous studies of development of the cerebellum have been performed on fetal specimens, and few in vivo studies discuss development of the cerebellar vermis per se.

MATERIAL & METHODS

Retrospective analysis of the midline sagittal views of the cerebellar vermis was performed in over 130 consecutive fetal MR examinations performed for CNS and non-CNS indications. Analysis included identification of the fastigial

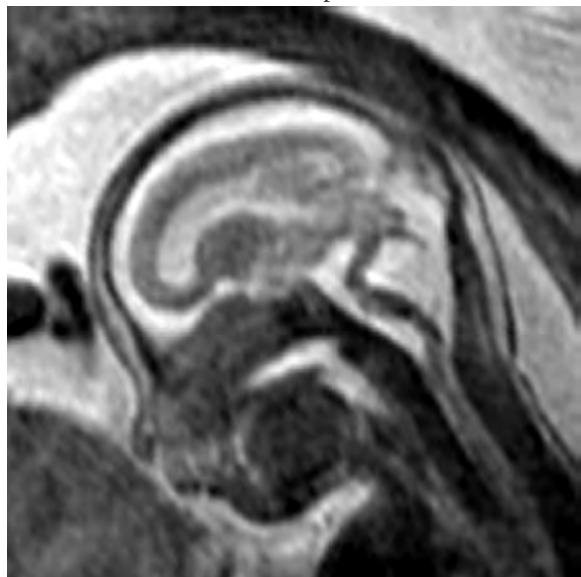
point and vermian fissures, degree of coverage of the fourth ventricle, cerebellar growth and proportions, tegmento-vermian angle, and associated abnormalities of the posterior fossa, brainstem and CNS.

RESULTS

Gestational age ranged from 14.9 to 38.6 weeks with a mean of 26.6 weeks. Useful midline sagittal views were obtained in over 100 studies. Approximately one quarter of these had abnormalities affecting the posterior fossa. These included fetuses with classic Dandy-Walker malformations and others within the Dandy-Walker spectrum which we subdivided according to presence of dysplasia or hypoplasia, abnormal tegmento-vermian angle, size of cisterna magna, and associated CNS abnormalities. Correlation with coronal and axial MR images and ultrasonographic images is demonstrated in addition to clinicopathologic and genetic diagnoses where available, however the final numbers are few.

CONCLUSION

We demonstrate MR imaging appearances of the normal and abnormal cerebellar vermis and posterior fossa with ultrasonographic and clinicopathologic correlation.
Part 2 of 2. See abstract 852 for part 1.



KEY WORDS: Vermis, fetal MR, Dandy-Walker

Poster 155

Diffusion Tensor MR Imaging and Fiber Tractography in Focal Cortical Dysplasia

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Seoul, REPUBLIC OF KOREA

PURPOSE

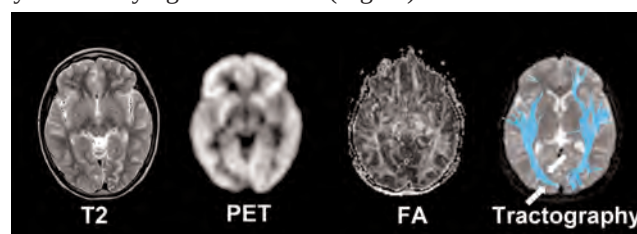
To evaluate the usefulness of diffusion tensor imaging (DTI) in describing white matter changes and to investigate the potential use of fiber tractography to detect alterations in fiber connectivity in the case of focal cortical dysplasia (FCD).

MATERIALS & METHODS

Nine patients with focal cortical dysplasia (M:F = 3:6, Mean age = 13.6 years) were evaluated by DTI. Fractional anisotropy (FA) and apparent diffusion coefficient (ADC) of white matter adjacent to FCD was measured by semiquantitative ROI method and compared to the normal contralateral side by t-test. Fiber tractography was obtained in each patient around the areas of white matter abnormalities with the threshold values of fiber tracking termination as FA = 0.2 and trajectory angle = 45°, and their configurations were investigated visually.

RESULTS

Significant FA reduction and ADC increase were found in two patients ($p < 0.0001$, t-test) who also showed hyperintensity on T2-weighted imaging. One patient who showed increased signal intensity of occipitotemporal white matter on T2-weighted imaging showed nearly the same FA values as the normal contralateral side. The rest 6 patients, who demonstrated normal signal intensity of white matter adjacent to FCD, did not show significant FA or ADC changes in comparison to the normal contralateral side white matter. On fiber tractography, all patients showed reduction of subcortical fibers and connection between subcortex and deep white matter, even in the cases of normal FA and T2 signal intensity of underlying white matter (Figure).



CONCLUSION

Diffusion tensor imaging and fiber tractography is unparalleled by any other imaging techniques in describing altered fiber connections and white matter changes in the cases of FCD.

KEY WORDS: Cortical dysplasia, MR imaging, diffusion tensor MR imaging

Poster 156

Neuroimaging of Craniosynostosis

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PURPOSE

The imaging of craniosynostosis children is well represented in literature. However, very little exists describing the post-operative appearance and subsequent long-term changes in the skulls of children with craniosynostosis.

MATERIALS & METHODS

From a series of 75 children of varying age and craniosynostosis types, we have selected several examples demonstrating the pre and postoperative changes. Over the last 5 years we have accumulated 75 patients with varying forms of craniosynostosis. These 75 patients had corrective surgery

at Tulane University between January of 1998 and September of 2003. The patients were examined by CT with 3D reconstructions. From these 75 patients, we chose 6 patients in which we display pre and postoperative examinations. An example of a sagittal, coronal, metopic lambdoidal, multisuture, and total suture synostosis are presented.

RESULTS

Studies obtained between birth and 6 months for preoperative assessment were of limited value due to the general paucity of calcification of the cranium. However, from 6 months to 1 year, complete ossification and closure of sutures was detected easily with the exception of the lambdoidal suture. Partial closure of this suture was more difficult to detect than complete closure of the suture. Immediate postoperative studies and follow-up exams subsequently show the appearance of the postoperative skull and the typical growth after repair. CT scanning with 3D reconstructions show the suture ossification quite readily and is a good modality for a pre and postoperative assessment of these patients.

CONCLUSION

We reviewed 75 patients with craniosynostosis. CT scanning with 3D reconstructions were utilized for preoperative and postoperative evaluation. The above poster outlines the appearance of the preoperative craniosynostosis patient and typical follow-up after surgery over a 5-year period.

KEY WORDS: Craniosynostosis

Poster 157

Investigation of Neurovascular Abnormalities in Sturge-Weber Syndrome Using Susceptibility-Weighted Imaging

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PURPOSE

Sturge-Weber syndrome (SWS) is an often progressive rare neurocutaneous disease manifesting as facial and leptomeningeal venous angiomas. Neurologic deterioration is suspected to be incident to abnormal collateral venous drainage and progressive venous occlusions (1-3). Susceptibility-weighted imaging (SWI) has been found to be particularly well suited for visualization of venous malformations and microhemorrhage within the brain (4-6). In this study, we present preliminary data investigating the use of SWI in SWS.

MATERIALS & METHODS

Six patients diagnosed with SWS were imaged at 1.5 T using a standard Siemens head coil. The imaging protocol consists of both a conventional T1-weighted fast spin-echo and a susceptibility-weighted sequence. The susceptibility-weighted sequence used is a high-resolution, three-dimensional, fully velocity compensated gradient-echo sequence, with postpro-

cessing involving combining both the magnitude and phase images to increase the conspicuity of the veins and other sources of susceptibility effects. All patients had pre and postcontrast T1 FSE and postcontrast SWI; a single patient additionally had precontrast SWI.

RESULTS

In the involved cortex, contrast-enhanced (CE) T1 images show leptomeningeal enhancement. Susceptibility-weighted images clearly show the abnormally large collateral veins along with ill-defined areas of T2 shortening that may represent calcification or deoxyhemoglobin. Susceptibility-weighted images are complementary to T1 images, displaying the specific location and extent of dysplastic veins compared to the diffuse enhancement seen with CE T1. Even without the administration of a contrast agent, SWI is able to clearly demonstrate the venous anomalies.

CONCLUSION

Susceptibility-weighted imaging enhances the visibility of venous abnormalities to a greater extent than conventional methods, as it relies upon the BOLD effect of deoxyhemoglobin (4-6). Contrast agent administration improves venous visibility, especially of small subvoxel veins (5). Susceptibility-weighted imaging in SWS shows the leptomeningeal enhancement of CE T1 images, but adds the clear visualization of areas of venous abnormalities, possibly including calcifications. Since regions of venous angiomatosis are associated causally with areas of neuronal degeneration (1-3), early detection may be important for potential therapeutic intervention. Susceptibility-weighted imaging may improve the early detection of vascular pathology in patients with SWS and contribute to the pathophysiologic understanding of its progression.

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KEY WORDS: Sturge-Weber, Susceptibility-weighted imaging, BOLD

Poster 158**Coarctation of the Lateral Ventricles: A Pictorial Essay**

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To illustrate the various appearances of coarctation of the lateral ventricles, an undiagnosed variant of normal.

MATERIALS & METHODS

The case of a patient with coarctation of the ventricles was studied longitudinally using the following imaging modalities; fetal ultrasound, fetal MR imaging and neonatal brain ultrasound and MR imaging. Other cases are presented to better illustrate the features of coarctation of the lateral ventricles.

RESULTS

Coarctation of the lateral ventricles is a common variant of normal that is often misdiagnosed as subependymal cysts secondary to subependymal hemorrhages or periventricular leucomalacia. It is located typically at the same level as the frontal horns of the lateral ventricles on coronal images whereas subependymal cysts are located below that level and periventricular leucomalacia above it. To our knowledge, our case is the first case reported to show the features of coarctation of the lateral ventricles using fetal MR imaging. We also present a case with concomitant intraventricular hemorrhage that demonstrates the absence of communication between the CSF in the coarctation and the CSF in the lateral ventricle. The typical appearance of coarctation of the lateral ventricles is that of multiple tear-shaped cysts in the typical location having a content that is isoechoic to CSF on brain ultrasound and isointense to CSF in all sequences on brain MR studies.

CONCLUSION

Coarctation of the lateral ventricles is a common variant of normal that can be misdiagnosed as subependymal hemorrhages or periventricular leucomalacia. Its appearance on fetal ultrasound, fetal MR imaging and neonatal neuroimaging studies is specific and should enable one to make the proper diagnosis.

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KEY WORDS: Coarctation, lateral, ventricles

Poster 160**West Nile Encephalitis in an 11-Year-Old Male with Postinfectious Parkinson's Disease**

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Wichita, KS**PURPOSE**

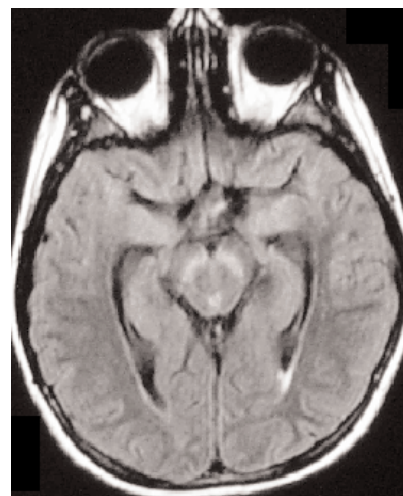
A case report of West Nile Encephalitis with secondary diagnosis of postinfectious Parkinson's disease in an 11-year-old previously healthy male is reported. The clinical and radiographic features of this case are discussed with a review of the literature.

MATERIALS & METHODS

Multiple imaging studies are obtained including: CT of the head without contrast, three subsequent MR images of the head with and without contrast, and MR spectroscopy study of the brain. Lumbar puncture was performed day of admission with multiple laboratory results obtained. The patient's history, physical exam, and hospital course are reviewed.

RESULTS

MR exams show bilateral increased signal within the mid-brain, substantia nigra, and posterior aspect of the thalami. The CSF shows leukocytosis with elevated protein and glucose. Cerebral spinal fluid serology confirms elevated IgM antibodies to the West Nile Virus.

**CONCLUSION**

West Nile Virus is an arbovirus first seen in the United States in a 1999 New York City outbreak. By 2003, this virus has spread to almost every state. Neurologic symptoms commonly affect the elderly and rarely affect children. The incubation period is 5-15 days and presents symptomatically as a febrile illness of sudden onset. According to the CDC, the most conclusive diagnostic method to identify persons with West Nile Virus infection of the central nervous system is detecting WNV-specific IgM antibody in CSF using ELISA. Because IgM antibody does not readily cross the blood-brain barrier, IgM antibody in CSF strongly suggests acute CNS infection. The clinical and radiographic features of this confirmed case are discussed with an updated review of the literature.

KEY WORDS: West, nile, virus

Poster 161

Single-Shot Fast Spin-Echo Diffusion MR Imaging of the Brainstem and Cerebellum in Premature Newborns

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PURPOSE

The utility of single-shot fast spin-echo (SSFSE) diffusion tensor imaging (DTI) for acquiring minimally distorted images has been established at 1.5 T used for the study of adult and pediatric brain (1, 2). The purpose of this study was to improve diffusion tensor MR imaging of the brainstem and cerebellum of preterm newborns using the SSFSE sequence, and thereby accurately measure the rotationally-averaged apparent diffusion coefficient (Dav) values in these posterior fossa regions in infants with and without white matter (WM) injury.

MATERIALS & METHODS

Twenty-three premature newborns were studied at 27-40 weeks of gestational age on a 1.5 T Signa EchoSpeed System (GE Medical Systems, Milwaukee, WI) using an specialized MR compatible incubator and a custom-designed neonatal head coil (3). Conventional MR imaging was performed to assess the severity of WM injury using a previously established scoring system: 0 (normal) to 3 (severely abnormal) (4). Diffusion tensor imaging scans were acquired with 18 cm FOV, 5 mm thick, 128 x 128 FreqPhase, b-value was 600 s/mm². Dav-map was generated as the mean of the eigenvalues of the tensor. Dav was calculated in 10 regions: cerebral peduncles, superior colliculi (G1), inferior colliculi (G1), hippocampus (G3), ventral pons (G2), dorsal pons (G1), deep cerebellar WM, cerebellar cortex(G3), ventral medulla (G2), and dorsal medulla (G1). The hippocampus was included for comparison purposes. The ROIs were grouped further into 3 regions: G1 dorsal, G2 ventral, and G3 gray matter group. Differences in Dav across regions, age, and the severity of white matter injury were analyzed using a mixed random effects model.

RESULTS

Dav differed significantly between regions, as demonstrated in Table 1. Dav significantly decreased over this gestational age range for all regions except the cerebral peduncles, the ventral and dorsal medulla. The Dav ($\times 10^{-3}$ mm²/s) within the three groups of regions (dorsal 1145.8 $\pm$ 14.0, ventral 1299.6 $\pm$ 15.4, GM 1334.7 $\pm$ 15.1) also were found to be significantly different; dorsal vs ventral ($P < 0.0001$), dorsal vs GM ($P < 0.0001$) and ventral vs GM ($P = 0.049$). They also were found to significantly correlate with gestational age at the time of scan with dorsal group $P = 0.022$, ventral group $P = 0.033$, and gray matter group of $P < 0.0001$. Also, Dav did not show significant differences between WM injury groups ($p = 0.064$).

Table 1. Dav ($\times 10^{-3}$ mm²/s) squares means*, standard errors** and p-values

	1	2	3	4	5	6	7	8	9	10
	1180	1114	1130	1317	1295	1129	1253	1350	1304	1198
	18.5	18.5	18.3	18.3	18.1	18.1	18.1	18.1	19.2	18.8
Cerebral Peduncles (1)		0.034	0.25	<.0001	<.0001	0.22	0.010	<.0001	<.0001	1
Superior Colliculi (2)			1	<.0001	<.0001	1	<.0001	<.0001	<.0001	0.002
Inferior Colliculi (3)				<.0001	<.0001	1	<.0001	<.0001	<.0001	0.028
Hippocampus (4)					0.98	<.0001	0.035	0.80	1	<.0001
Ventral Pons (5)						<.0001	0.48	0.12	1	<.0001
Dorsal Pons (6)							<.0001	<.0001	<.0001	0.022
Deep Cerebellum (7)								<.0001	0.20	17
Cerebellar Cortex (8)									0.42	<.0001
Ventral Medulla (9)										<.0001
Dorsal Medulla (10)										

CONCLUSION

This study demonstrated the feasibility of using a SSFSE-DTI sequence to obtain DTI parameters in the brainstem and cerebellum of premature newborns. Significant regional and temporal variations in Dav were observed, agreeing with known maturational changes. From early in life to term, there was a significant decrease in Dav in many brainstem regions with different rate of maturation as shown by the earlier maturation of dorsal group (lower Dav) and later maturation of ventral group (higher Dav).

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KEY WORDS: Diffusion, ssfse, neonate

Poster 162

Malignant Cord Compression in the Pediatric Population: Clinical and Imaging Features

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PURPOSE

To present the differences in the clinical and imaging features of pediatric and adult patients with malignant cord compression.

MATERIALS & METHODS

Retrospective study of 1200 patients seen over a 10-year-period at the oncology clinic of a tertiary care pediatric hospital. Clinical charts and all available imaging studies were reviewed.

RESULTS

Sixteen patients with malignant cord compression were identified. Patient's age at time of presentation was from birth to 19 years (mean: 9 years). The delay between the appearance of symptoms and diagnosis was from no delay (birth) to 5 months (mean: 1.5 month). Pain, paresis, and sphincter dysfunction were the most common symptoms. The histologic diagnosis was sarcoma in 8 cases, neuroblastoma in 4 cases, lymphoma in 2 cases, primitive neuroecto-

dermal tumor and teratoma in one case each. The primary tumor was responsible for the compression in 12 cases (75%) and metastasis in 4 cases (25%). Symptoms of cord compression were the presenting clinical feature in 13 cases. A single site of compression was identified in 15 cases. In 50% of cases, the initial anatomical origin of the compression was paravertebral.

CONCLUSION

Malignant cord compression is a rare manifestation of childhood cancer. In contrast to what is found in the adult population, malignant pediatric cord compression is more often the first manifestation of the malignancy rather than a secondary sign, will be more often secondary to a sarcoma than to an epithelial metastasis, and will involve the cord at only one site. The anatomical origin of the compression is more often the paravertebral soft tissues rather the vertebra itself.

KEY WORDS: Metastasis, spine, children

Poster 164

Brain Apparent Diffusion Coefficient Decrease during Correction of Severe Hyponatremic Dehydration

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PURPOSE

To report brain diffusion MR findings in a neonate with severe hyponatremic dehydration, undergone too rapid correction and resulting in intracellular edema (osmotic edema) and in apparent diffusion coefficient (ADC) decrease. This case provides insight about cellular response to osmotic challenge and it represents a unique accidental human "model" of cytotoxic edema.

MATERIALS & METHODS

A 20-day-old baby, after prolonged starvation because of mother's psychiatric disorder, presented with marked dehydration and lethargy. At admission (0 hours) serum sodium level was 208 mEq/L. He was slowly hydrated with hyponatremic and glucose i.v. solutions, aiming to reduce serum sodium at a rate of less than 2 mEq/L per hour. Despite this procedure, at 9 hours he had repeated generalized seizures for about 6 hours. The neurologic status progressively normalized together with serum sodium level (Figure 1). At 4 months neurologic exam was normal.

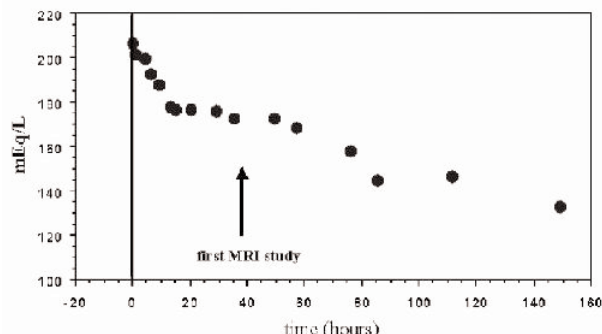


Fig. 1: sodium serum level time course.

RESULTS

MR findings: at 38 hours a MR scan showed diffuse remarkable brain swelling, with no parenchyma T2 signal increase, and generalized ADC reduction in gray matter and myelinated-unmyelinated white matter (Figure 2). A second MR imaging at 200 hours revealed normalization of ADC and no apparent brain anomalies.

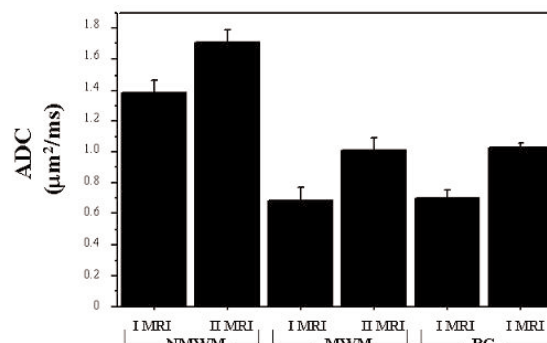


Fig. 2 legend: (NMWM) non myelinated white matter, (MWM) myelinated white matter, (BG) basal ganglia.

CONCLUSION

Animal models of hyponatremic dehydration (1, 2) strongly support the hypothesis that in our case dehydration induced intracellular accumulation of endogenous osmolytes to protect from water shifting from intra to extracellular space. During therapeutic fluid infusion, water molecules shifted from the extra to the intracellular compartment, due to the excess of intracellular osmolarity. It resulted in cell swelling and extracellular volume reduction. The effect was global brain swelling and generalized ADC reduction. The latter was apparently reversible. The ADC decrease during osmotic cell swelling supports the hypothesis that in acute ischemia cytotoxic cell swelling and extracellular volume reduction are the main causes of ADC decrease. Despite the total brain water increase (generalized brain swelling), T2 signal did not increase, confirming water in excess being bound within cells. Repeated ADC measurements during correction of severe osmotic unbalance might help in therapy planning.

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KEY WORDS: Diffusion MR imaging, cytotoxic edema, hyponatremia

Poster 165

Normal Maturation of Centrum Semiovale during Childhood: Diffusion Tensor MR Imaging with Segmentation-Based Measurement

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PURPOSE

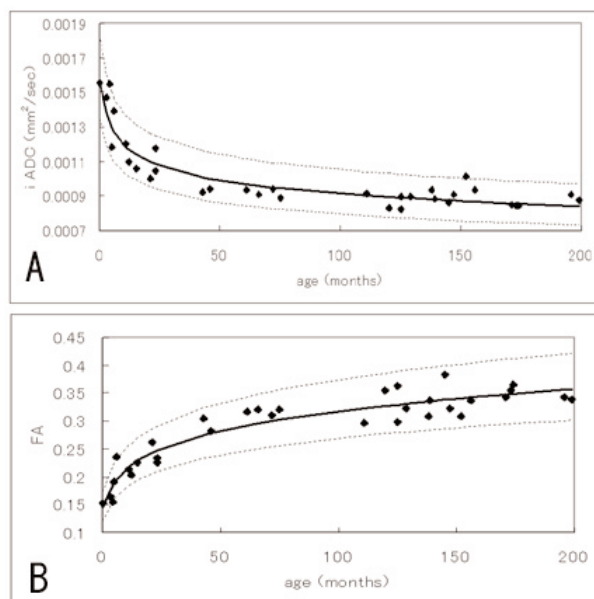
To characterize the maturational changes of diffusion tensor MR imaging indices within segmented white matter from a supraventricular slab.

MATERIALS & METHODS

We performed diffusion tensor MR imaging in 33 children (18 boys and 15 girls; age range, 6days-16 years) with a variety of clinical symptoms and signs, of which the most common were febrile seizure and headache. Significant abnormalities on conventional MR images and neurologic impairment as determined by a review of medical records were not found. Permission for usage of these data for research purposes was obtained from guardians and this reporting was approved by the institutional review board. MR imaging was performed on a 1.5 T clinical MR system. For diffusion tensor MR imaging, diffusion-weighted images [single-shot dual spin-echo echo-planar pulse sequence; 7400/102 msec(TR/TE); field of view 22 cm; 5 mm thick gapless; scan matrix 96 x 96] of 17-21 axial locations were obtained. Diffusion sensitizing gradients were applied in six different directions with b-value of 700 sec/mm². We generated pixel-by-pixel maps of isotropic apparent diffusion coefficient (ADC) and fractional anisotropy (FA) from the diffusion-weighted images and T2-weighted (b = 0 sec/mm²) images. 3D spoiled gradient-echo T1-weighted images [9.2/1.9 msec(TR/TE); field of view 22 cm; scan matrix 256 x 128; 1 mm thick] were obtained for tissue segmentation. We resliced the T1-weighted images with the corresponding imaging thickness and location of the T2-weighted images and segmented white matter from the resliced images automatically using brain image analysis tool, FSL (the Image Analysis Group, FMRIB, Oxford, UK). In each examination, a slab that included three continuous sections starting inferiorly from the top of the lateral ventricles, where the corpus callosum did not exist, was determined. We obtained means of isotropic ADC and FA values within the area corresponding to segmented white matter at the supraventricular slab for each subject. Nonlinear regression analysis was used for evaluating the relationship between the means of isotropic ADC and FA values and subject age.

RESULTS

In the Figure, scatterplots show mean isotropic ADC (A) and FA (B) values vs age. The data in A and B are fit to a mono-exponential model (solid lines) with determination coefficient (R²) of 0.893 and 0.909, respectively. The dotted lines denote the upper and lower limits of the 95% confidence interval s of means ADC and FA values at each age.



CONCLUSION

The diffusion tensor MR imaging indices derived from segmented white matter also can describe the maturational changes of centrum semiovale as the indices by region of interest (ROI) placement-based measurement that has reported (1). The segmentation-based measurement seems easy to eliminate bias in the placement of ROIs and regional variations of diffusion anisotropy in white matter.

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KEY WORDS: Diffusion tensor MR imaging, brain white matter maturation, children

Poster 166

Fetal MR Imaging in the Diagnosis and Management of Fetal Head and Neck Masses

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PURPOSE

To determine whether fetal head and neck masses are better characterized with fetal MR imaging than with prenatal ultrasound and to evaluate how fetal MR imaging alters family counseling and treatment decisions regarding fetuses with head and neck masses.

MATERIALS & METHODS

We searched our institution's imaging data base for fetuses with head and neck masses. Six patients were identified. All underwent prenatal ultrasound and fetal MR imaging at our institution. Fetal MR images were reviewed by two neuroradiologists; all prenatal ultrasounds were reviewed by an

expert in obstretrical ultrasound. Imaging studies were analyzed based on the characterization, localization, extent and differential diagnosis of the mass lesion. Medical charts were reviewed to determine if MR imaging findings changed patient counseling or case management. Parents also were asked if they made decisions based on the MR results.

RESULTS

MR imaging did not change or narrow the differential diagnosis. However, it did define more clearly the location of the mass and its effects on surrounding structures such as oral cavity, oropharynx, and airway in all cases. Review of clinical records revealed a change in case management or patient counseling in every case. Four of six families stated that the imaging results did not influence their treatment decisions. One set of parents chose to terminate the pregnancy and one set of parents made their child "do not resuscitate" based on the MR results.

CONCLUSION

When a fetal head or neck mass is detected or suspected at US, fetal MR imaging may better characterize it and demonstrate additional findings that can alter treatment planning and case management.

KEY WORDS: Fetal, MR imaging, neck mass

The authors of this work have indicated the following affiliations/disclosures: Acuson: Consultant.

Poster 167

Utility of MR Spectroscopy for the Diagnosis of Attention Deficit/Hyperactivity Disorder

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PURPOSE

To assess the utility of MR spectroscopy (MRS) to establish a diagnosis of attention deficit/hyperactivity disorder (ADHD).

MATERIALS & METHODS

A group of 12 boys with ADHD were compared with 12 healthy boys of similar age. Diagnosis of ADHD was made according to DSM-IV criteria. An informed consent was signed by the caretaker. After medical screening, MRS was performed including three different cerebral areas: right prefrontal cortex, left prefrontal cortex, and left basal ganglia. A comparison was made of the following MRS parameters between cases and controls: N-acetylaspartate(NAA)/creatinine(Cr) ratio, choline(Cho)/Cr ratio, myo-inositol (mI)/Cr ratio, and glutamate peak. A comparison also was made of the neuronal activity by calculating the proportion between the NAA/Cr ratios in two given regions, namely, right frontal cortex/left frontal cortex, left basal ganglia/left frontal cortex, and left basal ganglia/right frontal cortex.

RESULTS

Twenty-four subjects were studied (12 cases and 12 controls). Median age in the ADHD group was 8.5 years (range, 7-11 years; SD = 1.48), and in the control group was 9.0 years (range, 7-11 years; SD = 1.29). All children were right-handed, except for two cases and two controls. Analysis of spectra showed no statistically significant difference in any parameter between cases and controls. However, analysis of the NAA/Cr ratios between two cerebral regions showed a statistically significant reduction of neuronal activity in left basal ganglia in comparison with right frontal cortex in children affected with ADHD ($p = 0.034$).

CONCLUSION

MR spectroscopy showed a reduction in the neuronal activity of left basal ganglia in children affected with ADHD and may prove to be a useful screening test in the diagnosis of ADHD in children.

KEY WORDS: MR spectroscopy, attention deficit disorder, hyperactivity disorder

Poster 168

Limited Benefit of Gadolinium in Diagnosing Cause of Radiologically Proven Cerebral Hemorrhages in Children under Two Years of Age

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PURPOSE

To evaluate the benefit of gadolinium in the MR evaluation of known intracranial hemorrhages in children under the age of 2 years and review the radiologic findings in this population.

MATERIALS & METHODS

During a 7.5-year period (1995-2002), 57 gadolinium-enhanced MR examinations of the brain were performed in children less than 2 years old with intracranial hemorrhages proven or suspected by CT, ultrasound, or previous MR imaging. The medical records, stated indications, and MR findings were reviewed retrospectively. Thirty-four (60%) of the patients were less than 2 weeks old.

RESULTS

Of the 57 examinations reviewed, 8 (13%) showed pathologic contrast enhancement. Of the 8, only 2 (4% of all examinations) revealed an enhancing tumor related to the bleeding: in both patients prior CTs were performed that indicated a probable mass associated with the hemorrhage. The remaining studies showed findings unlikely to be related to the bleeding: 2 patients had enhancing laminar necrosis, 3 had enhancing meninges likely secondary to irritation from the blood products, and 1 had an enhancing pineal gland probably not related to his right posterior fossa hemorrhage. No pathologic enhancement was appreciated in 49 studies. Findings which may be causatively related to the previously identified/suspected hemorrhages in these 49 cases included probable venous sinus thrombosis (5 cases), possible AVM (1 case), possible mass (1 case), and possible

cavernous hemangioma (1 case). The remaining 41 exams did not reveal an underlying brain structural abnormality that might have been related to the hemorrhage. Altogether, in 47 (82%) patients, the MR examinations failed to reveal any underlying pathology of the hemorrhages.

CONCLUSION

Administration of gadolinium in children under the age of 2 years with radiologically proven/suspected cerebral hemorrhages to search for underlying pathology was only helpful in an extremely small percentage of cases.

KEY WORDS: Intracranial hemorrhage, gadolinium, MR imaging

Spine 169-185

Poster 169

Severe Thoracic Kyphosis in the Older Patient in the Absence of Vertebral Fracture: Association of Extreme Curve with Age

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PURPOSE

Limited imaging data are available on the natural history of thoracic kyphosis in older patients. The purpose of this study was to determine the distribution of the thoracic kyphotic angle in older patients without vertebral body abnormality when compared to a young population.

MATERIALS & METHODS

Thoracic kyphosis was measured by Cobb angle on standing lateral erect chest X-rays in 52 older patients (age > 65 years) and in 63 young patients (age < 35 years). Only patients with normal-appearing spines were included and patients with scoliosis, vertebral compression, vertebral body angulation, or congenital anomaly were excluded. Results were tabulated, graphically plotted, and analyzed.

RESULTS

In older patients (age > 65 years), the average thoracic kyphotic angle was 41.7 degrees (s.d. $\pm$ 12.6) but the distribution was bimodal with a lower mode at 29° and a higher mode at 50°. Both men and women were affected equally. In older men, the distribution was bimodal with a lower mode of 29 degrees and an upper mode of 48 degrees ($p < 0.05$). In older women the lower mode was 29 degrees and the upper mode was 54 degrees ($p < 0.05$). In young patients, average thoracic kyphotic angle was 26.8 degrees (s.d. $\pm$ 10.1). Surprisingly, the distribution in young women was also bimodal ($p < 0.01$) with a lower mode of 17 degrees and an upper mode of 38 degrees. The difference in average kyphotic angle between the older and younger population was statistically significant ($p < 0.001$).

CONCLUSION

An exaggerated thoracic kyphotic angle is common in older patients even in the absence of vertebral body abnormality such as height loss or compression. A bimodal distribution is present with a subpopulation of older men and women significantly more affected by progressive kyphosis. Causes of this bimodal distribution could include asymmetric disk space degeneration or innate hypermobility. Elder men and women with an exaggerated thoracic kyphotic angle might identify a population at risk for future vertebral body compression fracture, in particular with the development of bone loss and osteoporosis. In addition, the value of vertebral body height restoration with the vertebroplasty or kyphoplasty techniques must be considered in light of this data when treating vertebral compression fractures.

KEY WORDS: Thoracic kyphosis, osteoporosis, vertebral fracture

Poster 170

Choice of MR Sequences in Ankylosing Spondylitis Patients

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PURPOSE

Ankylosing spondylitis (AS) is a major representative of the family of seronegative spondyloarthritides where spine and joints are involved with a strong postinflammatory osteoplastic tendency. Spinal MR imaging precisely differentiates signal changes of the soft tissues, bone marrow, and medulla and therefore represents the best method focussing to the AS spinal ligament and bony changes. The aim of the study was the evaluation of the inner contribution of various MR sequences to AS diagnosis.

MATERIALS & METHODS

We prospectively studied 15 patients (5 women + 10 men, age 20-59 years, average age 35.93 years) with verified active AS. All patients were investigated by a rheumatologist and a neurologist. Four patients suffered from II stage, 5 from III one, 5 from IV stage and one from V stage of AS. MR investigation of the spine was made in: spin-echo (SE), turbo spin-echo (TSE) short tau inversion recovery (STIR) and combination of SE with gradient-echo (GraSE) in T1- and T2-weighted images on 1.5 T MR scanner without using contrast, 3 mm slices in sagittal and transversal planes were made.

RESULTS

Patients with AS quite often showed osteochondrosis (12 patients, 80%), anterior longitudinal ligament hypertrophy (6 patients, 40%), yellow ligament hypertrophy (6 patients, 40%), and spinal stenosis (5 patients, 33.33%). Vertebral synostosis and the posterior longitudinal ligament hypertrophy were found only in one patient (6.67%). T1-weighted imaging in SE mode exactly viewed the morphological changes and size of spinal components. Combination of gradient-echo and SE cuts down the investigation time slightly, but has no contribution to the diagnosis.

CONCLUSION

In our study we observed that in MR T2-weighted imaging in TSE mode represent the best possibilities of imaging of either changes in bone marrow or the ligament and soft tissue changes of patients with ankylosing spondylitis, while fat saturation can add more precise localization but prolongs the imaging time. The differences between inflammatory and noninflammatory changes cannot be differentiated on non-contrast MR scans.

KEY WORDS: Ankylosing spondylitis, MR imaging, sequences

Poster 171

Diffusion-Weighted MR Imaging of Lumbar Intervertebral Disk Disease with Measurement of Apparent Diffusion Coefficient

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PURPOSE

To our knowledge, there have been a few reports about diffusion-weighted MR imaging with echo-planar sequence (DW EP) utilized for spinal lesions. Some of them provided additional information for differential diagnosis. However, DW EP may fail to demonstrate some spinal lesions due to its unavoidable image distortion from susceptibility artifact, especially in intervertebral disk. Diffusion-weighted MR imaging with single-shot fast spin-echo sequence (DW SSFSE) is expected to improve conspicuousness of lesions because of its lower susceptibility effect. The purpose of this study was to evaluate the feasibility and utility of DW SSFSE in patients with lumbar intervertebral disk disease with measurement of apparent diffusion coefficient.

MATERIALS & METHODS

The diffusion-weighted imaging with single-shot fast spin-echo sequence (DW SSFSE) was implemented on a 1.5 T Signa Horizon LX MR imaging system (General Electric Medical Systems, Milwaukee, WI). A posterior spine coil was used for RF reception of the NMR signal. All images were acquired with slice thickness = 4 mm, FOV = 30 x 18 cm, NEX = 4, matrix = 128 x 128. Four images in the one sagittal plane were acquired with diffusion sensitization along the three directions with TR = 5002 ms, TE = 70.5 ms, b = 1000 s/mm² following an acquisition with b = 0. The total imaging time was 80 s. Lumbar vertebral disk apparent diffusion coefficients (ADCs) were calculated in regions of interest (ROIs) from DW SSFSE images positioned to avoid partial volume errors from the vertebral body. Fourteen normal volunteers and 23 patients with lumbar disk degeneration (n = 11), hernia (n = 10) or diskitis (n = 2) were examined on this study. The mean age was 52 ± 18 years old. In six patients, a syringe of distilled water was scanned simultaneously and the ADCs were calculated as a reference.

RESULTS

The mean ADC value of the lumbar vertebral disk in normal volunteers was $1.62 \pm 0.33 \times 10^{-3} \text{ mm}^2/\text{s}$ (mean $\times 10^{-3} \text{ mm}^2/\text{s}$ ± standard deviation). The mean ADC value of the lumbar vertebral disk in patients with lumbar degenerated disk was

$0.74 \pm 0.28 \times 10^{-3} \text{ mm}^2/\text{s}$, which was significantly lower than that of normal volunteers. And the ADC value was lower than other normally appearing disks of the same patients. In the three patients with diskitis, the disks showed slightly high signal intensity on T2-weighted images. However, they were low intense on DW SSFSE images and the mean ADC value was $(1.49 \pm 0.32 \times 10^{-3} \text{ mm}^2/\text{s})$ higher than the value of other normally appearing disks of the same patients. The ADC values of distilled water ($2.46 \pm 0.14 \times 10^{-3} \text{ mm}^2/\text{s}$) were almost the same as the known values. Discussion: Decrease of mean ADC values in the degenerated disk also is consistent with diminished disk water diffusion in degenerative intervertebral disk. In diskitis, higher ADC of the affected disk than normal appearing disk supported an association of increased disk water diffusion and inflammatory disease. Apparent diffusion coefficient measurement might be helpful to diagnose diskitis if vertebral signal changes were not remarkable, which were difficult to detect only on conventional MR images.

CONCLUSION

In conclusion, DW SSFSE is a useful technique for ADC measurement of the human lumbar vertebral disk and may be reliable for differentiation of lumbar intervertebral disk disease.

KEY WORDS: Diffusion-weighted MR imaging, lumbar intervertebral disk disease, apparent diffusion coefficient

Poster 172

Benign Conditions Afflicting the Posterior Elements of the Pediatric Spine: A Pictorial Essay Emphasizing MR Imaging and CT

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PURPOSE

Extensive work has been reported on imaging of traumatic conditions of the pediatric cervical spine. Our focus is on benign process affecting the posterior column of the cervical spine in children.

MATERIALS & METHODS

We present typical CT and MR features of osteomyelitis, aneurysmal bone cyst, eosinophilic granuloma and spina bifida with a congenital dermal sinus cyst.

RESULTS

Our goal is to increase awareness of these benign processes to expedite prompt treatment.

CONCLUSION

More importantly, the correct identification of these benign entities will prevent unnecessary procedures in children.

KEY WORDS: MR imaging, spine, posterior elements

Poster 173**Spinal Cord Subependymomas: Radiopathologic Correlations**

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PURPOSE

To describe two cases of subependymoma of the spinal cord, the MR appearances, the operative, and histopathologic findings.

MATERIALS & METHODS

We report two cases of spinal cord subependymomas, one thoracic, and the other in the filum terminalis. Both patients presented, with a long history of paresthesia and low extremities weakness, one patient had bladder dysfunction. In the first case, the MR shows a fusiform dilatation of the thoracic spinal cord from the inferior aspect of T7 through the mid aspect of T10, multiloculated with high signal intensity on T2-weighted imaging, intermediate signal intensity on T1-weighted imaging and minimal enhancement after gadolinium. In the second case, the MR imaging reveals the presence of a homogeneous mass, isointense on T1-weighted imaging; slightly hyperintense on T2-weighted imaging and strongly enhancing postgadolinium injection. The lesion is attached to the filum terminalis. We describe the operative findings and the complete histopathologic examination, including electron microscopy (EM).

RESULTS

Subependymomas are rare, benign, slow growing, well circumscribed tumors, corresponding histologically to WHO Grade 1, located most frequently in the fourth ventricle (50-60%), and lateral ventricles (30-40%) (1, 2, 4). They occur very rarely in the spinal cord: only 42 cases of spinal subependymomas have been reported in the literature until now (1-3). The majority of the tumors are intramedullary, the cervical region being their most common location (3, 4). In contrast with intracranial subependymomas, spinal subependymomas are symptomatic because of the limited space within the spinal cord. Clinically they present with motor and sensory deficits of the extremities, with or without back pain, similar to other intrinsic spinal cord tumors (1). The spinal subependymoma originates near the central canal. They are characterized by clusters of ependymal cells arranged within a dense glio-fibrillary matrix, occasionally containing microcysts (1, 4).

CONCLUSION

Even if subependymomas do not have a specific appearance on imaging, it is very important to differentiate them from astrocytomas and ependymomas. Subependymomas are benign lesions, cured by total surgical resection and no radiotherapy is required (1, 5). The hypothesis of subependymomas should be considered in case of spinal cord tumors and electron microscopy is mandatory to confirm the diagnosis.

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KEY WORDS: Spinal cord, tumor, MR imaging

Poster 174**Cystic Lesions in Lumbar Spinal Canal**

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Cystic lesions within the lumbar spinal canal are seen infrequently. Different pathologic processes can present as cystic lesions within the lumbar spinal canal. A knowledge of such lesions will be helpful in narrowing the differential diagnosis. Extramedullary cysts of the lumbar spinal canal may produce a slowly progressive myelo-radiculopathy, or radiculopathy. CT myelography and MR imaging have improved detection and understanding of these cysts. Currently, MR is the imaging modality of choice for the diagnosis and CT myelography is most helpful in establishing communication of the cyst with the subarachnoid space. In the future, CSF flow sensitive MR techniques will be available to accurately diagnose the cystic lesions of spinal canal and to determine their communication with the subarachnoid space. Surgical resection of symptomatic lesions usually results in complete cure or significant neurologic improvement. This work reviews the classification, pathophysiology, clinical presentation, and imaging features of lumbar extramedullary spinal cysts. The significant types include - synovial cysts, ganglion cysts, perineural cyst, cystic primary and secondary neoplasms, neuroenteric cysts, infectious processes, resolving hematoma, intra and extradural meningeal cysts, occult sacral meningocele, and imaging mimics of cystic lesions.

KEY WORDS: Spinal canal, neoplasms, cysts

Poster 175**Percutaneous Treatment of Lumbar Facet Joint Synovial Cyst: Technical Approach and Clinical Results**

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PURPOSE

To describe technical and procedural features of percutaneous treatment of lumbar facet joint synovial cysts along with its radiologic aspects and to assess the clinical efficacy.

MATERIALS & METHODS

The intervention is performed under CT guidance and local anesthesia with the patient in prone position; a 22 gauge needle is positioned either into the articular space or directly into the cyst itself. The first approach is preferred since contrast medium injection following needle placement confirms communication of the cyst with the synovial space and thus the articular nature of the lesion. Subsequently the cyst is filled with steroids (betamethasone 6 mg/ml) in a variable quantity until rupture of the cyst is achieved. The cyst rupture is confirmed by diffusion of the contrast material into the epidural space (Figure). Nine patients have been treated so far this way.



Figure: needle placed in the articular space and contrast medium in the ruptured cyst and diffusing through the ipsilateral foramen.

RESULTS

In all cases direct puncture of the cyst or of the synovial space was obtained as well as, in every case, filling of the cyst with contrast medium and rupture after steroid injection. Clinical results are favorable in a 3- to 18-month follow-up. One patient was retreated with the same technique owing to recurrence of pain 3 months after the first treatment.

CONCLUSION

Percutaneous treatment of lumbar facet joint synovial cysts is easy, safe and, in our limited series, effective. This technique deserves to be proposed as first choice before a more aggressive surgical treatment.

KEY WORDS: Spine, facet joints, interventional procedure

Poster 176**Post Lumbar Diskography CT: Angiography CT vs Conventional CT**

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PURPOSE

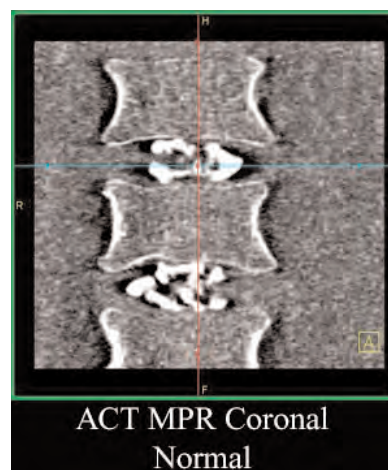
To evaluate the utility of angiography CT (ACT) vs CT for the evaluation of the disk space following lumbar diskography.

MATERIALS & METHODS

Ten patients underwent provocative lumbar diskography for the evaluation of diskogenic low back pain on a standard angiography table equipped with rotational 3D imaging. Angiography CT (rotational sequence) was performed immediately following completion of the study. Routine conventional postdiskography CT was obtained within 1.5 hours following the procedure. Angiography CT images of the injected disk spaces were reviewed in standard orthogonal planes (MPR) on a 3D workstation in a bone window and compared to routine helical CT for the distribution and extent of annular fissuring.

RESULTS

Angiography CT provided nearly equivalent diagnostic quality images of the disk space/nuclear morphology following lumbar diskography when compared to conventional CT. The restricted axial FOV required additional acquisitions in some cases. Angiography CT had the advantage of being able to be performed immediately following diskography thereby limiting the dissipation of the injected contrast.



CONCLUSION

Angiography CT is a promising new technique that has the potential to obviate the need for conventional postdiskography CT in the evaluation of the lumbar disk, as well as saving time, cost, and radiation exposure to the patient.

KEY WORDS: Lumbar diskography, CT

Poster 177

Incorrect Needle Positioning during Lumbar Epidural Steroid Administration: Inaccuracy of Loss of Pressure Resistance and Requirement of Fluoroscopy and Epidurography during Needle Insertion

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PURPOSE

Midline lumbar epidural steroid injections are commonly performed blindly without fluoroscopic guidance, using the "loss of resistance" technique (1). The purpose of this study was to evaluate the need for imaging assistance during midline lumbar epidural steroid injection (LESI) by establishing the incidence of inaccurate extracanal needle placement with loss of pressure resistance.

MATERIALS & METHODS

A single operator performed 25 consecutive midline LESI procedures during a 3-month period. After trajectory toward the posterior lumbar epidural space was determined and local anesthetic applied, a 20 gauge Tuohy needle was inserted into the back soft tissues and connected via a short tube to a standard 3 cc syringe filled with 1.5 cc air and 1.5 cc non-ionic contrast. Needle was advanced to the epidural space and intermittent testing with air in the air/contrast syringe was performed to establish persistent positioning in the back soft tissues. When pressure resistance in the syringe was lost, a small amount of contrast was injected to determine needle tip positioning. If the tip remained outside the spinal canal and not in the posterior epidural space, the needle was further advanced with fluoroscopic assistance until the space was entered accurately. The incidence of false position of the needle outside the spinal epidural space was reviewed retrospectively and tabulated.

RESULTS

In 4 of 25 patients (16%), resistance to syringe air pressure was lost during needle insertion while the needle tip position was still within the back muscles and soft tissues. In one instance, tip position was recognized easily as quite far from the spinal canal. In 3 patients, the tip position was overlying the region of the spino-laminal line and hypertrophic facets suggesting that the tip position could be correct. Contrast injection confirmed tip position external to the ligamentum flavum and still in the back soft tissues. When the posterior epidural space finally was entered, epidurogram with contrast injection confirmed correct needle tip positioning.

CONCLUSION

Simple loss of air pressure resistance is an inadequate method of establishing needle tip positioning in the posterior epidural space. Inaccurate needle tip position in the back

soft tissues occurs in 16% of procedures using a relatively large (20 gauge) Tuohy needle. Fluoroscopy and contrast injection with epidurogram is essential to establish incorrect needle tip positioning and confirm epidural position when the canal is correctly engaged (2).

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KEY WORDS: Epidural steroid, lumbar, technique

Poster 178

Visualization of Percutaneous Vertebroplasty Needle Tracks on Postprocedure CT: Is the Needle Along the Intended Path?

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PURPOSE

Percutaneous vertebroplasty (PV) with polymethyl-methacrylate (PMMA) can be via a uni or bipedicular approach. For the unipedicular approach, a more oblique transpedicular course is desired to achieve a final midline position in the vertebral body. However, during fluoroscopy, the exact transpedicular trajectory of the needle in the axial plane is unknown. The needle track may be seen on CT following PV and can help verify the operator's technique. We describe in this presentation our technique for the unipedicular approach and review the post-PV CT scans to determine the frequency of an identifiable needle track.

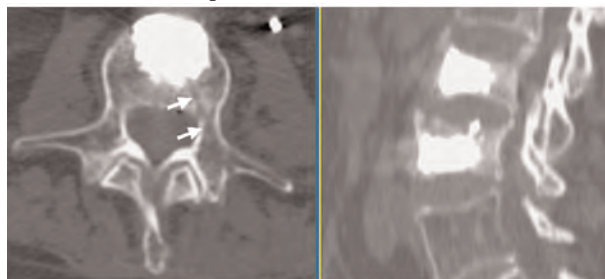
MATERIALS & METHODS

The approach angle for a unipedicular injection is determined from the preprocedure CT and the image-intensifier (I-I) is rotated relative to the midline spinous process. The 11/13 gauge needle is aligned "down the barrel." The I-I then is rotated back to a position where the pedicle is best visualized. The needle is advanced through the pedicle ensuring not to breach the pedicle's medial cortex. Twenty consecutive patients who underwent PV were evaluated. Nineteen patients had symptomatic (subjectively described to be > 7/10 on a pain scale), clinically reproducible pain, from osteoporotic compression fractures; 1 had PV for metastases. Seventeen patients had post-PV CT scans available and formed the study population. Each CT was reviewed retrospectively for an identifiable needle track by 2 neuroradiologists experienced in performing PV. A needle track was defined as a contiguous, lucent line, seen through the pedicle and/or vertebral body, with or without associated PMMA along the tract. Errors in needle placement were defined as tracks contiguous with fracture lines from needle placement or breaks in the medial cortical margin of the pedicle. The adequacy of vertebral body filling with PMMA was judged subjectively by distribution and volume to be good or unsat-

isfactory. Clinical follow-up was performed from telephone interviews with a significant reduction in pain defined as a 4-point decrease in pain score.

RESULTS

Percutaneous vertebroplasty was performed at 25 levels (14 in the lumbar and 9 in the thoracic spine). Fourteen levels were treated via a unipedicular approach and 11 via a bipedicular approach. Needle tracks were identifiable in 28 of 36 (78%) pedicles. One of 36 (3%) had an associated thoracic rib fracture secondary to attempted costotransverse-pedicular approach. Good filling of the vertebral body with PMMA was seen in 24 of 25 (96%) levels. Clinical follow-up was available in 16 patients, with 12 (75%) reporting significant reduction in pain.



CONCLUSION

The track and trajectory of the needle used for injection of PMMA in PV is identifiable in a significant proportion of patients on postprocedure CT scans. This information can be useful for those learning PV to judge the adequacy of their technique, so that optimal needle placement can be achieved.

KEY WORDS: Vertebroplasty, CT, technique

Poster 179

Vertebroplasty of Compression Fractures of the Spine with Retropulsed Fragments Causing Canal Stenosis

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PURPOSE

Vertebroplasty is an effective method for treating compression fractures of the spine. However, the method always has been limited in the case of more severe fractures, particularly those with fragments of bone retropulsed into the spinal canal.

MATERIALS & METHODS

We have treated an initial series of 10 patients who presented with symptoms of debilitating pain from compression fractures and had large fragments in the canal creating greater than 40% canal stenosis. No patients presented with symptoms related to spinal stenosis. The patients were not considered surgical candidates (for a variety of reasons) and were treated with vertebroplasty alone.

RESULTS

The procedure was technically successful in all cases, with no complications. Specifically, there was no evidence of movement of the fragments or worsening of the canal stenosis. No patients developed symptoms related to canal stenosis.

CONCLUSION

MR/CT imaging was helpful in evaluating these fractures and planning treatment. Symptomatic relief was achieved in many patients, but not at the rate seen in patients with less severe fractures.

KEY WORDS: Vertebroplasty, stenosis

Poster 180

Magnetization Transfer Characterization of Axonal Changes Post Spinal Cord Transection in Live Lamprey Spinal Cord

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PURPOSE

Magnetization transfer (MT) can enhance tissue contrast and provide information on neural tissue composition based on the exchange of ¹H magnetization between pools of relatively free water and protons with restricted motion (1, 2). In a previous study (6) we found that in the normal lamprey spinal cord the calculated magnetization transfer ratios (MTRs) were determined by the membrane density. We used features of sea lamprey spinal cord, characterized by rapid spontaneous axonal regeneration after injury (3), to determine whether changes in MTRs may correlate with changes in axon density in response to trauma and repair.

MATERIALS & METHODS

Twenty-nine larval sea lamprey spinal cords were studied (six excised normal spinal cords, five at 2 and six for each 5, 10, and 15 weeks after injury). The excised cords were placed in a capillary tube filled with Ringer solution and then in a home-built solenoid transmit-receive RF coil (1.5 mm diameter) (4, 5). MT micro-MR imaging was performed on a 400 MHz system. We used a conventional spin-echo sequence with and without a presaturation MT block pulse applied 6500 Hz off water resonance. Two 0.25 mm thick sections were selected, at 2.5 mm rostral and caudal to the injury site. The in-plane resolution was 23 x 23 microm². Spinal cord viability was maintained by limiting scan time and keeping coil temperature as low as possible. The ROIs were placed on different regions of the white matter (note that lamprey lacks myelin and WM is used only as a convention for the regions of SC that comprise axons) and MTR computed for all the drawn ROIs.

RESULTS

The ROIs were placed on the dorsal columns of WM above the injury site, containing ascending sensitive fibers and also on the ventral columns below the transection site, containing

descending motor fibers. The calculated MTRs in all drawn ROIs decreased progressively, reaching their minimum ($P < 0.05$) at 10 weeks after injury, and then returned toward the values before injury. These changes in MTR correspond to axonal degeneration and regeneration on the NF immunostained sections.

CONCLUSION

The present study results - MTR decreasing as axons degenerate and recovering toward normal values while axons regenerate and the animal functionally recovers - support our hypothesis that MTR may be used to detect and semiquantitatively assess changes in axon density in response to trauma and repair. In our animal model the MTR variance appears to be determined by the change in axolemmal density that follows transection. This method may have potential for monitoring the severity of axonal injury and response to therapy, in animal models and possibly in humans.

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KEY WORDS: Axonal degeneration and regeneration, lam-prey, magnetization transfer

Poster 181

MR Imaging of the Cervical Spine Utilizing 3D Phase-Cycled Fast Imaging Employing Steady-State Acquisition at 3 T: Advantages and Challenges

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PURPOSE

To investigate the benefits and challenges of imaging the cervical spine at 3 T utilizing 3D phase-cycled fast imaging employing steady-state acquisition (3D FIESTA-C).

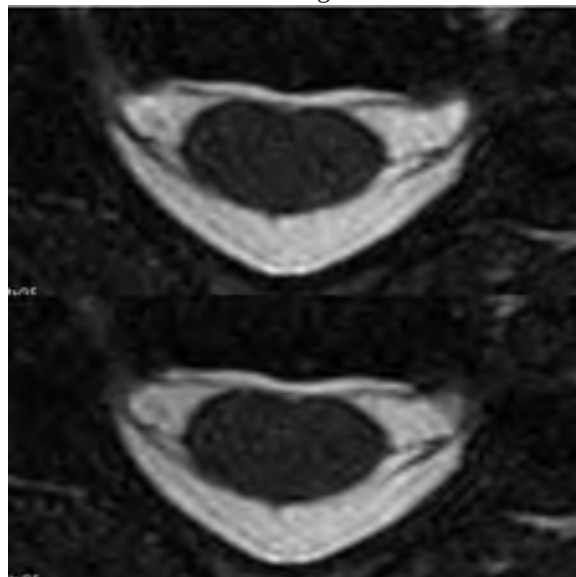
MATERIALS & METHODS

An ongoing study was initiated to develop a high-resolution, myelographic protocol for MR imaging of the cervical spine at 3 T. Normal volunteers were imaged on a 3 T system (GE, Waukesha, WI) using a 3D FIESTA-C sequence and a linear phased-array surface cervical spine coil (Clinical MR Solutions, LLC, Brookfield, WI). Three-dimensional FIESTA-C is an imaging sequence that acquires two or more steady-state free precession (SSFP) image volumes in which the typical SSFP (off-resonance) banding artifacts are spatially shifted with respect to each other (1). The image volumes then are combined to remove the banding artifacts (2). Parameters including bandwidth, flip angle, field of view (FOV), slice thickness, and matrix size were varied to obtain the highest resolution acquisition while maintaining adequate contrast to noise ratio (CNR) between the cerebral spinal fluid (CSF), cord, nerve roots, as well as extradural structures, all within an acceptable scan time defined as

under 6 minutes. The myelographic effect of this sequence, as well as the conspicuity of the ventral and dorsal nerve roots and the dentate ligament, then were evaluated.

RESULTS

This investigation examined normal volunteers with a median age of 33 years. A flip angle of 35-45°, bandwidth of 32 kHz, FOV of 10 cm, slice thickness of 2 mm, matrix of 256 x 192, NEX of 1, and a TR of < 10 msec provided good contrast to noise (CNR) between the CSF, cord and nerve roots, and extradural structures. The average sequence time was 4.8 minutes. Empirically, a TR < 10 msec was necessary to avoid CSF pulsation artifacts. Sufficient CNR also was observed with thinner slices (1.4 mm interpolated to 0.7 mm), however this increases the scan time to 5.4 minutes. Our protocol was not limited by CNR; CNR was acceptable with 8 cm FOVs (TR = 12 msec), but flow voids became more evident because of the longer TR.



CONCLUSION

Faster MR imaging gradient hardware has produced myelographic SSFP-based sequences that approach the diagnostic accuracy of CT myelography (CTM) (3). To date, most publications focus on exams at 1.5 T (3, 4, 5). Here, the increased signal levels available using the 3 T scanner are exploited to obtain higher resolution myelographic images than are available at 1.5 T. With 3 T, using a phase-cycled SSFP technique to reduce banding artifacts becomes important for two reasons: to compensate for the increased susceptibility at 3 T and the longer TRs necessary to acquire higher resolution images. Additionally, depending on the protocol, the minimum TR or flip angle may be limited by SAR at 3 T. To the extent that the TR is lengthened to conform to SAR limitations, additional flow-compensation gradient waveforms may be added to the SSFP sequence, potentially improving reliability for subjects with highly pulsatile CSF flow or allowing higher resolution studies. The 3T 3D FIESTA-C MR examinations consistently produced high-quality, high-resolution images, with superior CNR between the CSF and cervical nerve roots giving a reliable noninvasive myelographic study.

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KEY WORDS: Cervical spine, 3 T, 3D FIESTA-C

Poster 182

MR Findings of Epidural Analgesia Mimicking Spinal Epidural Abscess

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PURPOSE

Spinal epidural abscess is one of the major complications of epidural analgesia for back pain, which MR findings have been reported by several authors. However, it is supposed that the continuous injection via epidural catheter may cause the abnormal MR findings mimicking spinal epidural abscess even without infection. The purpose of this study is to assess the MR findings of epidural analgesia.

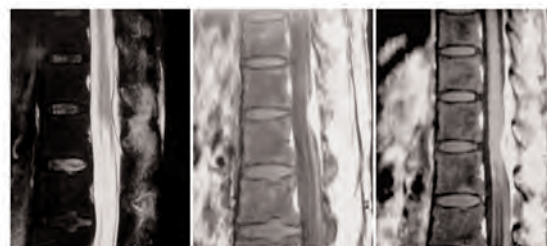
MATERIALS & METHODS

MR findings of five patients who underwent epidural analgesia were evaluated retrospectively. The reasons for performing MR imaging included catheter dysfunction in two patients, and fever, lumbago, and follow-up (no symptom) in one each. Axial and sagittal, T1- and T2-weighted spin-echo (SE) imaging and postcontrast fat suppressed T1-weighted SE were performed. In three patients with catheter dysfunction or fever, presence of infection was denied microbiologically. Each case was evaluated for MR signal intensity, location, extent, delineation, and enhancement pattern. In three cases with catheter dysfunction or fever, follow-up MR imaging was performed within 5 to 70 days, and the interval change of the MR findings also was evaluated.

RESULTS

In all five cases, the posterior epidural lesions were identified; the lesion showed iso to hypointense relative to the spinal cord on T1-weighted images, isointense to CSF on T2-weighted images, and homogeneous enhancement on postcontrast images. The abnormal enhancements extended from two to seven vertebral bodies in length. In three cases,

the enhanced lesion had some mass effect compressing the thecal sac. Follow-up MR imaging demonstrated no interval changes in all three cases.



T2WI

CE T1WI

CONCLUSION

Chronic epidural analgesia may show similar MR findings to epidural abscess.

KEY WORDS: Spine, MR imaging, infectious diseases

Poster 183

Emerging Role of 16-Row Multidetector CT Angiography in the Diagnosis and Management of Acute Cervical Fractures

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PURPOSE

Our objective is to present the emerging role of 16-row angiography (MDCTA) in the diagnosis and management of acute traumatic cervical fracture and associated vascular injuries.

MATERIALS & METHODS

A 0.5 sec rotation, 16 slice helical CT (Somatom Sensation, Siemens) was used. Image parameters were: single breath acquisition at 120 kVp and 200 mAs, slice width = 2 mm, collimation of 1.5 mm and table speed of 24 mm per gantry rotation. Injection of 120 cc of nonionic contrast medium was given at rate of 4 cc/sec through an 18G catheter. Bolus triggering with a threshold of 120 HU was utilized. Three-dimensional VRT and MIP reformations were generated from axial source images at workstation. Upon identifying fractures with possible vascular injuries, MDCTA from the aortic arch to the circle of Willis was performed immediately.

RESULTS

Sixteen-row MDCTA has been able to demonstrate a plethora of vascular injuries such as great vessel transection, dissection, and pseudoaneurysms. It also is useful in assessing therapeutic neurointerventional procedures. This exhibit demonstrates 16-row MDCTA of the head and neck, and associated CT findings of acute cervical fractures. Sixteen-row MDCTA allows shorter acquisition times, greater coverage, and superior image resolution often obviating the need for conventional or digital angiography.

CONCLUSION

In the evaluation acute cervical fracture that may involve vascular injury, the use of 16-row MDCTA enables the radiologist to produce timely vascular maps that clearly identify not only the fracture but also the salient vascular findings and often obviating the need for conventional or digital angiography.

KEY WORDS: Multidetector CT angiography, cervical fracture, vascular injury

Poster 184

Willisian Collateral Circulation Is Not a Determinant of Infarct Volume or Infarct Topography in MCA Stroke

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PURPOSE

Willisian collaterals play a prominent role in the setting of carotid stenosis or occlusion. Primary collaterals at the circle of Willis also may sustain perfusion in distal leptomeningeal anastomoses during acute ischemia due to middle cerebral artery (MCA) occlusion. We assessed the relationship of vascular patency in the intracranial circulation with infarct volume and infarct topography in MCA stroke.

MATERIALS & METHODS

Retrospective review of simultaneous MR imaging and MR angiography (MRA) studies in 96 cases (median age 65 years, range 18-89 years; 54:42 M:F) of MCA stroke. Vascular patency in each segment of the intracranial circulation on MRA was graded as occluded, exhibiting partial flow, or patent. MCA infarct topography and volume calculations were determined from diffusion-weighted sequences. Multivariate logistic regression analysis determined predictors of infarct volume and infarct topography based on vascular patency data.

RESULTS

MCA territory infarcts (51:45 L:R) were classified as full in 15 cases. Partial cortical involvement was noted in 71 cases, with divisional infarcts in 17. Partial subcortical lesions were noted in 32 cases, with isolated lenticulostriate involvement in 10 cases. Infarct volume (mean 35.2 cm², SD $\pm$ 39.5 cm²) correlated with lesion topography. MCA patency was predictive of infarct volume ($p = 0.05$) and infarct topography. MCA occlusion correlated with lenticulostriate involvement ($p = 0.05$), although cortical infarction was variable. Internal carotid artery patency and presence or absence of all components of the circle of Willis exhibited no relationship with infarct volume. Even in cases of MCA occlusion, the presence of Willisian collaterals were not predictive of infarct volume or infarct topography.

CONCLUSION

Willisian collaterals demonstrated on MRA are not predictive of infarct volume or infarct topography in MCA stroke. Infarct volume is determined by the degree of vascular occlusion in the proximal MCA. Cortical sparing and the extent of infarction in MCA stroke may be determined by leptomeningeal collaterals, yet the depiction of Willisian collaterals on MRA does not reflect such secondary collateralization.

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KEY WORDS: Collateral circulation, stroke, MR angiography

Poster 185

Quantitative MR Findings in Patients with Mild to Moderate Carpal Tunnel Syndrome

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PURPOSE

To evaluate quantitative MR findings of the median nerve especially in relation to clinical symptoms in patients with mild to moderate carpal tunnel syndrome.

MATERIALS & METHODS

We performed high resolution MR of the carpal tunnel in 30 subjects with mild to moderate carpal tunnel syndrome who were participants in one of two on-going prospective studies. All subjects had standardized nerve conduction studies, clinical evaluations, and completed questionnaires that included the Carpal Tunnel Syndrome Assessment Questionnaire (CTSAQ), a well validated measure of symptoms (11 questions) and function (8 questions), scored on 1-5 scale with 1 being best function/symptoms and 5 worst. High resolution images were obtained using phased-array wrist coils: 1. coronal SE, TR = 600, TE minimum, 18 cm FOV, 256 x 192 matrix, 4 mm thick, 4 minutes; 2. axial T1-weighted SE, TR = 450, TE minimum, 10 cm FOV, 256 x 256 matrix, 4 mm thick, 1 mm skip, 5.5 minutes; 3. axial fast-STIR, TR = 3650, TE = 54, TI = 160, echo train length = 6, 10 cm FOV, 256 x 224 matrix, 4 mm thick, 1 mm skip, 5.25 minutes. Two readers, blinded to all clinical information, independently measured the median nerve width, height, and area at preselected anatomically defined points (distal radio-ulnar joint, pisiform, hook of the hamate, and the beginning of the proximal metacarpals). Measurements also were made where the

nerve was largest in cross-sectional area as where the nerve was 'flattest' in configuration. Carpal tunnel area was measured at the hook of the hamate and where the nerve was flattest. Finally, the length of median nerve signal abnormality was measured. We used bivariate correlation and linear multivariate regression to evaluate the association between MR findings and symptoms as measured by the CTSAQ. We anticipate 150 subjects to be enrolled by June, 2004 and also will incorporate nerve electrodiagnostic studies into the data analysis.

RESULTS

The mean age was 48 years (range 32-69 years), 27 (90%) subjects were female and 26 (87%) were white. Mean symptom score was 2.92 (0.77 sd) out of 5; the mean functional status score was 2.56, (0.90 sd). Inter-reader reliability was moderate to high for the majority of measurements (significant Pearson correlations 0.78-0.91) except for the distal radio-ulnar joint and 'flattest' configuration. The nerve area at its largest point was associated positively with both symptom and functional summary scores, day pain, numbness, and weakness. The extent of abnormal signal was associated with symptom and function summary scores, severity of nighttime and daytime pain, and weakness.

CONCLUSION

MR imaging can be used reliably to quantitatively measure the carpal tunnel and median nerve. Limitations include resolution at the edge of the coil, which may be responsible for poorer inter-reader reliability at the proximal metacarpal joint. The nerve area at its largest point and the length of signal abnormality were associated with symptoms and function. Comparison will be made with electrodiagnostic studies.

KEY WORDS: Carpal tunnel, MR imaging, peripheral nerve

Notes:

Notes:

Scientific Exhibits 1-115

Exhibit Hall 4B (Level 4)

Monday, June 7

6:00 PM – 9:00 PM

Tuesday, June 8 - Thursday, June 10

6:30 AM - 9:00 PM

Friday, June 11

6:30 AM – 11:45 AM

NOTE: eSE = Indicates abstract is part of the electronic Exhibit (eSE) Pilot Project and can be viewed in the Computer Exhibit area.

A missing Scientific Exhibit number indicates an abstract has been withdrawn.

**Adult Brain
1-66**

Scientific Exhibit 1

Brain Diffusivity in Patients with Neuropsychiatric Systemic Lupus Erythematosus and New Acute Neurologic Symptoms

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PURPOSE

To investigate whether diffusion-weighted imaging can depict cerebral abnormalities in patients with acute symptoms of neuropsychiatric systemic lupus erythematosus (NPSLE) and if significant differences in measured ADC histograms between these patients and normal controls exists.

MATERIALS & METHODS

Conventional MR imaging of the brain and diffusion-weighted echo-planar imaging (DWI) were performed on 1.5 T scanner (GE Medical Systems) in 11 female NPSLE patients, aged 35-59 years, mean 44.4 years, and in 11 age-matched healthy controls. Whole brain apparent diffusion coefficient (ADC) histograms were composed in all patients. To remove noise and CSF explicit cuts were done at $100 \times 10^{-6} \text{ mm}^2/\text{sec}$ and $2000 \times 10^{-6} \text{ mm}^2/\text{sec}$ 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 extended the histogram was (kurtosis) was evaluated in each subject. Average values and SD was calculated. P-value < 0.05 was set for statistical significance using Students t-test.

RESULTS

Ten of the eleven patients (90%) 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. The NPSLE patients had a mean ADC value of $1012 \times 10^{-6} \text{ mm}^2/\text{sec}$ and the control had a mean ADC value of $973 \times 10^{-6} \text{ mm}^2/\text{sec}$. The mean ADC values were significantly higher ($p < 0.02$) in the NPSLE patients compared to the controls. There were no statistical significant differences in the width, skewness, or kurtosis between the two groups.

CONCLUSION

ADC histogram analysis demonstrated increased general diffusivity in the brain in NPSLE patients with acute symptoms as compared with healthy normal controls. This finding suggests that in the brain parenchyma of NPSLE patients a loss of tissue integrity occurs and facilitates motility of free-water protons. However larger studies are needed to evaluate the present method for its value to study disease progression, or its use in treatment control.

KEY WORDS: Brain diffusivity, apparent diffusion coefficient, neuropsychiatric systemic lupus erythematosus

Scientific Exhibit 2

Which Exam to Perform in Cerebral Venous Thrombosis: MR Imaging or Multislice CT?

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PURPOSE

To describe direct and indirect signs of cerebral venous thrombosis (CVT) using MR imaging, MR venography (MRV), CT and CT venography (CTV).

MATERIALS & METHODS

From our experience and from literature data, we evaluated accuracy of MR imaging (1.5 T, GE and Siemens) and CT (16-slice CT, Siemens) in CVT diagnosis.

RESULTS

The presentation contains: a) A brief description of normal cerebral venous anatomy; b) An illustration of direct signs (intraluminal thrombus) and indirect signs (cerebral edema, venous infarction, subarachnoid hemorrhage, subdural hematoma) of CVT; c) A comparison of different MRA sequences (3D phase-contrast, 2D time-of-flight, gadolinium-enhanced 3D MRV); d) The contribution of non-enhanced CT and CTV with emphasis on postprocessing (multiplanar reconstruction, volume rendering technique); e) The potential pitfalls in CVT diagnosis; f) A comparison of CTV and MRV.

CONCLUSION

Both MR imaging and multislice CT are highly accurate for CVT diagnosis. The main advantage of MR imaging is evaluation of parenchymal changes. Conversely cerebral venous system is better visualized by multislice CT.

KEY WORDS: Cerebral venous thrombosis, MR imaging-MR venography, multislice CT-CT venography

Scientific Exhibit 3

Dynamic CT Perfusion Imaging with Acetazolamide Challenge for Evaluation of Cerebral Hemodynamics in Patients with Chronic Steno-Occlusive Vascular Disease

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PURPOSE

To investigate the validity of dynamic CT perfusion (CTP) with acetazolamide (ACZ) challenge for the assessment of cerebral hemodynamic changes in patients with chronic symptomatic atherosclerotic arterial steno-occlusive disease.

MATERIALS & METHODS

Dynamic CTP with ACZ challenge was performed in 25 consecutive patients (mean age 65 years, range 37 to 81 years) with unilateral occlusion or severe stenosis of their cerebral arteries. Regional cerebral blood flow (rCBF) of the same regions of interest before and after ACZ challenge were measured. Regional cerebrovascular reactivity (rCVR) then was calculated.

RESULTS

Four patterns of hemodynamic change involving the ipsilateral middle cerebral and/or anterior cerebral arterial territories were identified. There were 4 patients in type 1 (normal rCBF, normal rCVR); 6 patients in type 2 (normal rCBF, decreased rCVR); 10 patients in type 3 (decreased rCBF, decreased rCVR); and 5 patients in type 4 (decreased rCBF, normal rCVR).

CONCLUSION

Dynamic CTP with ACZ challenge can provide valuable hemodynamic information and depict abnormalities of perfusion in patients with chronic cerebral steno-occlusive disease.

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KEY WORDS: Acetazolamide, CT perfusion, cerebral artery occlusion

Scientific Exhibit 4

Cerebral Sinus Venous Thrombosis: The Challenge in Diagnosis

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PURPOSE

Cerebral venous sinus thrombosis remains an underdiagnosed disease. The clinical presentation of venous sinus thrombosis is nonspecific. Since the disease is relatively uncommon, it often is not suspected until the radiologist first suggests the diagnosis. When the disease is diagnosed early, effective treatment can be provided promptly. In contrast, delayed diagnosis and treatment can result in severe complications, such as cerebral hemorrhage, infarction or death. It is therefore paramount for the radiologist to be familiar with the clinical presentation, as well as the various radiologic features of the disease. The purpose is to review the pathophysiology, clinical presentation, and diagnostic features of cerebral venous sinus thrombosis.

MATERIALS & METHODS

A review of the current literature on the diagnosis of cerebral venous sinus thrombosis is conducted using Medline search and cross-referencing of the acquired literature. Literature in both children and adults is included. The results are pooled with the experience from our own institution.

RESULTS

We summarize the risk factors, clinical signs and symptoms of cerebral venous sinus thrombosis. A diagnostic algorithm is outlined. Diagnostic features of the disease on nonenhanced and contrast-enhanced CT, CT venography, MR imaging, MR venography and conventional angiography are demonstrated using the cases from our institution.

CONCLUSION

High clinical suspicion and familiarity of the diagnostic features of venous sinus thrombosis facilitate its early diagnosis, which can have a significant impact on the clinical outcome. Although MR imaging and MR venography remain the diagnostic test of choice, it remains important to be familiar with the diagnostic features on CT as it remains the most common screening study for patients presenting with neurologic complaints.

KEY WORDS: Venous, sinus, thrombosis

Scientific Exhibit 5

“Penguin Silhouette Sign”: Useful MR Diagnostic Sign for Progressive Supranuclear Palsy

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PURPOSE

Neuropathologically, progressive supranuclear palsy (PSP) shows marked atrophy of midbrain tegmentum. Penguins have small heads and big bodies. “Penguin Silhouette sign” was composed on midsagittal MR images in which midbrain tegmentum represents penguin’s small head and pons represents penguin’s big body (especially king penguin). The aim of this study was to establish diagnostic MR criteria and imaging sign (“Penguin Silhouette sign”) for the diagnosis of PSP.

MATERIALS & METHODS

MR images of 69 patients with Parkinsonian syndrome [21 patients with PSP, 23 patients with Parkinson disease (PD), 25 patients with multiple system atrophy, Parkinson type (MSA-P), 17 patients of multiple system atrophy, cerebellar type (MSA-C), three patients of corticobasal degeneration (CBD), five patients of dentatorubropallidolusian atrophy (DRPLA), three patients of Machado-Joseph disease (MJD) and 20 age-matched normal controls subjects were studied]. MR images of 69 patients with Parkinsonian syndrome [21 patients with PSP, 23 patients with PD, 25 patients with MSA-P and 20 age-matched normal control subjects were studied prospectively for measuring the area of midbrain tegmentum and pons and the ratio (area of the midbrain tegmentum/area of the pons)]. The areas of midbrain tegmentum and pons were measured on midsagittal MR images using display tools of the workstation belonging to the MR unit. The ratio of the area of midbrain tegmentum to the area of pons was evaluated also in all Parkinsonian syndrome and normal control subjects. The midsagittal MR images of all patients and normal control subjects were evaluated visually. The shape of midbrain tegmentum and pons (focusing its shape) resembles or does not resemble the penguin silhouette.

RESULTS

The average of the area of midbrain in patients with PSP (56.0 mm²) was significantly smaller than that in patients with PD (103.0 mm²) or MSA-P (97.2 mm²) and age-matched control group (116.9 mm²). The ratio of the area of the midbrain tegmentum to the area of pons in patients with PSP (0.124) was significantly smaller than that in patients with PD (0.208), MSA-P (0.266), and normal control subjects (0.237). On visual evaluation, all PSP patients, four of five patients of dentatorubropallidolusian atrophy, and one of three patients of corticobasal degeneration showed “Penguin Silhouette sign.”

CONCLUSION

The measurement of the area of the midbrain tegmentum on midsagittal MR images can be used as a reliable measure to differentiate PSP from other Parkinsonian syndrome and normal aging. “Penguin Silhouette sign” also can be a useful diagnostic sign for PSP. However, CBD and DRPLA can show this sign.

KEY WORDS: Progressive supranuclear palsy, Parkinsonian syndrome, MR imaging

Scientific Exhibit 6

Nuclei and Tracts of the Human Medulla: MR Microscopy at 9.4 T

Naidich, T. P. • Tai, A. W. • Delman, B. N. • Delgado, J. E. • Aguinaldo, J. G. S. • Perl, D. P. • Wolfe, D. E. • Hof, P. R. • Drayer, B. P.

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PURPOSE

The purpose of this study was to explore how well MR microscopy (MRM) could display the fine anatomical detail and 3D organization of the nuclei and fiber tracts of the human medulla.

MATERIALS & METHODS

Using previously reported methods (1), the normal nuclei and tracts of the human medulla were displayed in three orthogonal planes at a resolution of 60-70 microns (in plane) by 500 microns (slice thickness) using a Brüker Avance 9.4 T unit, intermediate-weighted pulse sequences (TR 2000, TE 30, 20 NEX, 3-3.5 cm field of view, 512 x 512 matrix) and three formalin-fixed human medullae from cadavers with no known neurologic disease. Nissl and Luxol fast blue stains provided precise correlation between the MR appearance and the nuclear and fiber tract anatomy of the very same specimens.

RESULTS

MR microscopy convincingly displays the sites, contours, and relationships among the hypoglossal, dorsal vagal, solitary, medial/ inferior vestibular, dorsal/ ventral cochlear, and spinal trigeminal nuclei and their tracts. The gracilis and cuneatus (medial and lateral) are seen to continue through the internal arcuate fibers, and then decussate to become the medial lemnisci. The dorsal longitudinal, medial longitudinal, and anterolateral fasciculi are defined clearly in relation to these structures. The inferior, the medial accessory, and the dorsal accessory olivary nuclei are displayed beautifully in relation to their encompassing amiculum. The pyramids, external arcuate fibers and nuclei, dorsal and ventral spinocerebellar tracts, restiform bodies and medullary striae define the surface. Multiple individual fascicles of the hypoglossal nerve easily are traced through the full thickness of the medulla from their origin in the hypoglossal nucleus dorsally, to course between the inferior and medial olivary nuclei, and then exit ventrally. Cine display permits the physician to trace individual structures through the length of the stem and helps to integrate their 3D relationships into a coherent image of brainstem structure.

CONCLUSION

MR microscopy at 9.4 T greatly advances the anatomical detail demonstrable in specimen medullae. Those familiar with this anatomy may well be able to appreciate finer anatomical features on clinical images obtained with the higher field 4.7 T, 7 T, and 8 T units now being introduced at selected sites.

REFERENCES

1. Fatterpekar GM, Naidich TP, Delman BN, et al. **Cytoarchitecture of the Human Cerebral Cortex: MR Microscopy of Excised Specimens at 9.4 Tesla.** *AJNR Am J Neuroradiol* 2002;23:1313-1321

KEY WORDS: Medulla, anatomy brain, MR microscopy

Scientific Exhibit 7**Nuclei and Tracts of the Human Midbrain: MR Microscopy at 9.4 T**

Naidich, T. P. • Delgado, J. E. • Delman, B. N. • Tai, A. W. • Aguinaldo, J. G. S. • Gultekin, H. S. • Perl, D. P. • Hof, P. R. • Delman, B. P.

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PURPOSE

The purpose of this study was to explore how well magnetic resonance microscopy (MRM) could display the fine anatomical detail and 3D organization of the nuclei and fiber tracts of the human mesencephalon.

MATERIALS & METHODS

Using previously reported methods (1), the normal nuclei and tracts of the human midbrain were displayed in three orthogonal planes at a resolution of 60-70 microns (in plane) by 500 microns (slice thickness) using a Brüker Avance 9.4 T unit, intermediate-weighted pulse sequences (TR 2000, TE 30, 20 NEX, 3-3.5 cm field of view, 512 x 512 matrix) and three formalin-fixed human mesencephala from cadavers with no known neurologic disease. Nissl and Luxol fast blue stains provided precise correlation between the MR appearance and the nuclear and fiber tract anatomy of the very same specimens.

RESULTS

MR microscopy convincingly displays the individual gray and white strata of the inferior and superior colliculi, their decussations and peduncles; and the intercollicular nuclei. The central gray matter is related to the dorsal and medial longitudinal fasciculi, the nuclei and tracts of the trochlear nerve, the nuclei and tracts of the mesencephalic trigeminal nerve, and the tectospinal tracts. Surrounding these, concentrically, lie the cuniform and interstitial nuclei, the spinothalamic, dorsal trigeminothalamic and central tegmental tracts, and the anterolateral fasciculi, enclosed by an outer ring formed by the medial lemnisci and red nuclei. The ventral midline displays the oculomotor and accessory oculomotor nuclei, the multiple individual fascicles of the third nerve, and the interpeduncular nuclei. The partes compactae and reticulatae of the substantiae nigrae and the tracts of the cerebral peduncles lie ventrolaterally. The trochlear nerves

decussate in the superficial medullary velum of the fourth ventricle and emerge just lateral to its frenulum. Cine display permits the physician to trace individual structures through the length of the stem and helps to integrate their 3D relationships into a coherent image of brainstem structure.

CONCLUSION

MR microscopy at 9.4 T greatly advances the anatomical detail demonstrable in specimen mesencephala. Those familiar with this anatomy may well be able to appreciate finer anatomical features on clinical images obtained with the higher field 4.7 T, 7 T, and 8 T units now being introduced at selected sites.

REFERENCES

1. Fatterpekar GM, Naidich TP, Delman BN et al. **Cytoarchitecture of the Human Cerebral Cortex: MR Microscopy of Excised Specimens at 9.4 Tesla.** *AJNR Am J Neuroradiol* 2002;23:1313-1321

KEY WORDS: Midbrain, brain anatomy, MR microscopy

Scientific Exhibit 8**MR Imaging of Hypertrophic Olivary Degeneration**

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PURPOSE

Hypertrophic olivary degeneration is a form of transsynaptic degeneration which develops as a result of focal lesions of the Guillain-Morraret triangle (dentate-rubro-olivary pathway), which is composed of the contralateral dentate nucleus, the ipsilateral red nucleus, and the ipsilateral inferior olivary nucleus. The degeneration is characterized initially by neuronal loss (T2 hyperintense olive of the medullar oblongata) followed by neuronal and glial hypertrophy (enlarged medullary olive). Clinically, the patients present with palatal myoclonus and an uncontrollable tremor. Identification of a T2 hyperintense hypertrophic olivary nucleus associated with a brainstem tegmental or cerebellar lesion makes other diagnoses such as infarction, demyelination related to multiple sclerosis, neoplasms and infectious or inflammatory processes less likely.

MATERIALS & METHODS

Magnetic resonance (MR) images and clinical presentation of five patients with olivary degeneration caused by cerebellar or brain stem pathology were reviewed.

RESULTS

Clinical presentation and MR findings of five patients with MR findings of hypertrophic olivary degeneration are presented.

CONCLUSION

The diagnosis of hypertrophic olivary degeneration should be strongly suggested by the presence of an olivary lesion in association with another lesion in the contralateral cerebellar dentate nucleus, contralateral superior cerebellar peduncle, ipsilateral red nucleus, or ipsilateral pontine tegmentum.

KEY WORDS: Olivary degeneration

Scientific Exhibit 10

Role of 3D MR Imaging in Current Treatment of Parkinson's Disease

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PURPOSE

The treatment of tremor disorders, particularly Parkinson's disease (PD), for those 10% of patients who do not respond to levodopa includes deep brain stimulators (DBS) targeting specific basal ganglia nuclei, and direct hormone replacement via MR stereotactic-guided microcatheters into the globus pallidus. Three most common sites for DBS are the globus pallidus interna to control rigidity in PD, ventrointermediate (VIM) nucleus of the thalamus to control essential and rest tremors of PD, and the subthalamic nucleus for improving not only tremors in PD but also akinesia, bradykinesia, and rigidity. Algorithmic formulas based on construction of an AC-PC (anterior and posterior commissure) line and brain atlas measurements exist for all three sites for DBS. However, direct targeting of these foci by the visualized anatomy is more accurate than the algorithmic formulas due to variations. Thus definition and recognition of the basal ganglia anatomy on MR imaging is critical for precise targeting. This exhibit will review the pertinent basal ganglia anatomy and illustrate how the foci are selected.

MATERIALS & METHODS

All patients were imaged on 1.5 T MR with routine sets of images as well as 1 mm reformatted T1-weighted MP-RAGE in all three planes with a Leksell head frame reviewed on a Leksell imaging workstation from 1999 to 2003. Targeting for subthalamic nucleus only dates back to 2001. The VIM was targeted in 40 and the bilateral subthalamic nucleus in nine. Additional 2 mm T2-weighted coronal images were obtained for the subthalamic nucleus patients. The globus pallidus was targeted for 10 patients for microcatheter insertions. The anterior and posterior commissures were identified on the 1 mm 3D volume images allowing the AC-PC line to be constructed. Both the algorithmic formula and direct anatomical visualization of the targeted nucleus were applied before making a final selection. Intraoperative microelectrode monitoring confirmed the targeting by characteristic electrical patterns.

RESULTS

The exact mechanism of DBS is not known, but unlike surgery DBS is reversible and more precise. Errors of 2-3 mm on initial targeting may require a second craniotomy defect/entry site and the stereotactic device reinserted. Only

one required retargeting after initial successful response. The T1-weighted MP-RAGE or GRASS 3D MR imaging was most accurate for measurements, but does not afford the best imaging of the basal ganglia. Thin section T2-weighted images even at 2 mm show enough distortion so they are not as accurate for localization. There was significant improvement in all 10 patients targeted for microcatheters.

CONCLUSION

Globus pallidus interna targeting utilizes the optic tract as a target point but there are variabilities in its location. The globus pallidus usually is seen well on the T1-weighted images. The VIM is located in the inferior and lateral portion of the thalamus in the anterior half on the sagittal. The subthalamic nucleus on axial is lateral to the midline red nuclei and posterior to the substantia nigra between the two. On the coronal the subthalamic nucleus is lateral to the massa intermedia and above it, and below the thalamus. Even with T2-weighted images the subthalamic nucleus was often difficult to see.

KEY WORDS: Deep brain stimulators, Parkinson's disease, basal ganglia targeting

Scientific Exhibit 11

Symmetrical Basal Ganglia Abnormalities on MR Imaging: Beyond the Calcifications

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PURPOSE

To demonstrate the broad spectrum of diseases which involve the basal ganglia in a symmetrical fashion.

MATERIALS & METHODS

We retrospectively reviewed the internal search engine (FOLIO VIEWS) at our institution since 1998 for MR imaging with basal ganglia signal abnormalities. Diagnosis was established by clinical findings, laboratory data and/or characteristic imaging findings.

RESULTS

We present a poster-based presentation of clinical and MR findings of disease entities such as Hallervorden-Spatz, Maple Syrup Urine, subacute necrotizing encephalopathy (Leigh disease), hepatolenticular degeneration (Wilson's disease), Huntington's, Parkinson's, carbon monoxide poisoning, anoxia/hypoxia/ischemia, manganese therapy, and hepatocerebral degeneration which cause symmetrical basal ganglia signal abnormalities.

CONCLUSION

A number of disease entities can affect the basal ganglia symmetrically. This exhibit will present the entities, clinical presentation, and characteristic MR imaging of patients with the varied diseases.

KEY WORDS: Basal ganglia

Scientific Exhibit 12

Toxic Leukoencephalopathy Secondary to Heroin Inhalation: "Chasing the Dragon"

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PURPOSE

To present a pictorial essay demonstrating the CT, MR imaging and MR spectroscopy findings of toxic leukoencephalopathy secondary to heroin vapor inhalation. Initial presentation, short-term and intermediate follow-up imaging findings are described. A brief description and history of heroin inhalation, also known as "chasing the dragon" as a form of heroin abuse, is provided.

MATERIALS & METHODS

Eight patients who presented within the past 2 years at UBC affiliated institutions are described. All patients had a history of drug abuse, including heroin and/or cocaine inhalation. Six of these patients were male and two were female. Most patients were of Asian descent. Noncontrast CT was performed in seven of the patients at initial presentation. MR imaging was performed within the first week following presentation in six patients. MR spectroscopy was performed in three patients. Two patients had follow-up studies at approximately 1 year. Three patients had follow-up studies at 10 days to 1 month after presentation.

RESULTS

The patient presentations were nonspecific, including obtundation, ataxia and a parkinsonian syndrome. All patients demonstrated striking symmetric white matter abnormalities, consisting of hypodensity on CT and T2/FLAIR hyperintensity on MR imaging within the cerebellum, peduncles, and posterior limbs of the internal capsules. More extensive involvement was seen in the more severely affected patients with additional symmetric involvement of the white matter of the parietal and occipital lobes and involvement of the white matter tracts of the brainstem. The imaging findings in our patients were typical of changes associated with heroin inhalation toxicity described in the literature. Of the two patients with 12-month follow-up, one demonstrated no change of initial findings and reported continued heroin abuse. The second patient demonstrated partial reversal of the initial CT changes with less prominent and less extensive hypodensity seen within the white matter at 12 months. The three patients with short-term follow-up demonstrated progression of the initial changes, with more marked hypodensity of the white matter and development of cerebral edema and hydrocephalus, paralleling clinical deterioration. MR spectroscopy showed decreased NAA levels and a lactate peak, suggesting anaerobic metabolism. Autopsy of one patient revealed spongiform degeneration of the white matter with vacuoles in the distribution of imaging abnormalities, findings considered characteristic of heroin inhalation toxicity.

CONCLUSION

Leukoencephalopathy due to inhalation of heroin pyrolysate, which was first described in the Netherlands in 1982, was not recognized at our institution until 2002. Since then, this entity has presented repeatedly in our patient population, suggesting an increased frequency of heroin administration by "chasing the dragon" or a new impurity in the cocaine/heroin obtained by drug abusers in this city. To date, a specific impurity responsible for this condition has not been identified. Given the unreliability of the patient population and vague clinical presentations, characteristic imaging findings are key to diagnosing this condition. Although treatment is mainly supportive, early intervention may help arrest progression of the white matter changes and identification of affected patients may assist in finding the toxic agent.

KEY WORDS: Toxic leukoencephalopathy, heroin, chasing the dragon

Scientific Exhibit 13

Spectrum of Imaging Features in Wilson's Disease

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PURPOSE

Wilson's disease (WD, hepatolenticular degeneration) is an autosomal recessive disorder of copper transport in which there are low levels of the serum transport protein ceruloplasmin as well as excessive binding of copper in the liver. After the liver is saturated, abnormally high amounts of copper accumulate in secondary organs such as the brain, kidneys, and eyes. Patients are imaged frequently to assess degree of parenchymal disease, but patterns of involvement can vary widely. This exhibit illustrates the spectrum of imaging features seen in patients with moderate to advanced Wilson's disease.

MATERIALS & METHODS

Between July 2000 and September 2003, eight patients (M:F = 5:3, mean age 22.8 ± 10.7 years) with clinically proven WD presented for MR scans in our department; eight were imaged once, four twice, and one thrice, yielding a total of 13 scans. In addition to routine brain imaging, eight examinations were performed with more advanced sequences such as spoiled gradient-echo volumetric imaging, axial high resolution T2-weighted imaging through the brainstem and basal ganglia, diffusion tensor, and spectroscopy.

RESULTS

Common findings in WD patients most characteristically include increased T2-weighted signal in the caudates and putamina, the regions also most likely to develop the cavitation that presumably correlates with necrosis, spongiform degeneration, and demyelination seen histologically. The thalami also are involved frequently, although the medial and posterior nuclei may be less involved. There also may be diffusely increased signal in the belly of pons as well as in pyramidal and extrapyramidal tracts in general, but some

certain tracts such as the medial longitudinal fasciculus and medial lemniscus can be spared. As in other liver disorders, hyperintensity on T1-weighted imaging in the basal ganglia may be related to manganese deposition rather than copper excess. Generalized atrophy is common with disease progression. Spectroscopic findings include reduced NAA/creatinine levels in the corpora striata, and elevated choline/creatinine in the belly of pons. A lactate doublet is noted in some. Changes over time are seen in those patients who underwent more than one scan. Specifically, the progression of cavitation, changes in NAA and lactate, and development of atrophy are shown.

CONCLUSION

Typical and less common imaging features of WD are discussed and the pathophysiology of WD is reviewed. Changes in disease appearance over time are identified also. Understanding of the imaging features in WD can suggest the diagnosis and characterize disease progression.

KEY WORDS: Wilson's disease, imaging, features

Scientific Exhibit 14

Chasing "Chasing the Dragon" with MR Imaging: Leukoencephalopathy in Drug Abuse

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PURPOSE

Spongiform leukoencephalopathy is a known rare complication from inhalation of heroin vapor, a practice commonly referred to as "chasing the dragon." The clinical onset of this disorder is relatively insidious and the patient histories are often confusing. However, the MR appearance of this disorder is dramatic and is considered pathognomonic for heroin-induced spongiform leukoencephalopathy. Multiple case studies have been published with various imaging techniques and proposed mechanisms of this disorder. Nonetheless, this phenomenon remains poorly understood. We present three new cases of leukoencephalopathy in drug abuse, showing that conventional MR findings are not pathognomonic for heroin vapor toxicity. Although one of our cases mimics the conventional MR findings of heroin vapor toxicity, this patient was a cocaine user, having never used heroin. We compared these findings with those from our known heroin-related cases via conventional MR imaging, MR spectroscopy, MR perfusion and MR diffusion-weighted imaging. Evaluating spongiform leukoencephalopathy in this setting provided additional clues to understanding the pathophysiology of heroin-induced spongiform leukoencephalopathy.

MATERIALS & METHODS

Two of our three patients presented in the subacute phase of their encephalopathy and had documented heroin abuse via drug pyrolysis and inhalation of the heated vapor. The third patient presented with an acute change in consciousness and although his MR findings were typical for spongiform leukoencephalopathy, his history and toxicology screen were positive for cocaine, benzodiazepines, and lidocaine, but not

heroin. Conventional MR imaging, MR spectroscopy, MR perfusion and MR diffusion-weighted imaging were performed in these cases and compared.

RESULTS

The conventional MR findings for all three patients were similar showing diffuse symmetrical white matter changes. In our heroin patients, MR spectroscopy showed an increase in lactic acid and myoinositol with normal N-acetyl aspartate, choline, and lipids. In our patient with cocaine exposure, MR spectroscopy showed an increase in lactic acid and in lipids. A five-month follow-up MR image was performed in one of our patients with heroin-related disease. He had progressive white matter changes and continued to have a marked increase in lactic acid, all in the setting of a normal MR perfusion study and with steady clinical improvement.

CONCLUSION

1) All three cases have MR findings suggestive of spongiform leukoencephalopathy. However, not all cases of diffuse, symmetric spongiform leukoencephalopathy are heroin-induced. MR spectroscopy may help to differentiate between toxicity due to heroin and other illicit substances. 2) In cases of heroin-induced change, the discordance between perfusion and spectroscopy (i.e., normal blood flow but elevated lactic acid) suggests that the disease is due to impaired energy metabolism at the cellular level. 3) MR findings of spongiform leukoencephalopathy secondary to heroin can progress despite abstinence of the drug and during clinical improvement. This suggests that the MR changes are an evolution of existing injury.

KEY WORDS: Heroin pyrolysis, spongiform leukoencephalopathy, chasing the dragon

Scientific Exhibit 15

Correlation of MR Findings with PET and SPECT Imaging in Intractable Epilepsy

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PURPOSE

The purpose of this exhibit is to evaluate the MR findings in patients with intractable epilepsy in correlation with PET and SPECT images and study the combined efficacy of MR imaging and nuclear studies in detection of lesions.

MATERIALS & METHODS

Most patients with intractable epilepsy had nuclear imaging studies performed in addition to the standard MR studies. A prospective and retrospective study of the imaging findings of such patients over a 1-year period in our institution was done. SPECT imaging in the interictal period and during the ictal phase in a few patients was performed. Selected patients also had FDG-PET imaging.

RESULTS

One of the most common abnormalities noted on MR imaging in patients with intractable epilepsy was mesial temporal sclerosis. Several of the patients also had normal MR stud-

ies. Interictal and ictal SPECT and PET studies performed in these patients were able to confirm the findings of MR imaging in localization of seizure focus in most cases. The sensitivity and predictive value of MR in these groups of patients with respect to the activity seen on nuclear studies was done and the results presented.

CONCLUSION

Standard MR imaging done with epilepsy protocol in combination with nuclear studies improves the efficacy in detection of lesions in patients with intractable seizures.

KEY WORDS: Intractable epilepsy, MR imaging, PET

Paper 15A

Epilepsy: The Emerging Role for the Neuroradiologist

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PURPOSE

Epilepsy is a common neurologic affliction of children and adults. It carries an estimated annual incidence of up to 1 per 1000, and a prevalence of up to 5 per 1000 children. The past 2 decades have seen a major advancement in understanding the causes of epilepsy that have changed significantly its management.

MATERIALS & METHODS

Records of the neuroimaging exams from a busy epilepsy service were reviewed. Patients with refractory epilepsy were selected for the study. All exams with identifiable brain lesions were reviewed and correlated with pathology reports when available. The images of the most interesting and clinically significant neuroanatomical substrates of epilepsy are presented and accompanied by an educational review.

RESULTS

This scientific exhibit will elucidate an overview of epilepsy for the neuroradiologist. The classification of different types of seizures will be reviewed. Common imitators of epilepsy are listed. A typical diagnostic flow diagram of the evaluation and treatment of epilepsy are displayed. The clinical diagnosis of seizures including typical EEG tracing, long-term video EEG monitoring, use of implantable electrode/grids are discussed. Underlying neuroanatomical etiologies for seizure are demonstrated in the form of multimodality neuroimaging and photomicrographs. A pictorial review of etiologies including congenital, focal cortical dysplasia, neuronal migration disorders, gliosis, mesial temporal sclerosis (MTS), dysembryoplastic neuroepithelial tumor, arachnoid cyst, vascular malformations, CVA, brain neoplasms, genetic syndromes (i.e., MELAS, Sturge-Weber) are demonstrated. Special attention is paid to MTS with its multiple manifestations, relative distribution, as well as common mimickers. The anatomy of the limbic system are reviewed using a combination of anatomical drawings and MR images. Multiple cases of MTS will be demonstrated to allow the neuroradiologist to gain experience in detecting this subtle finding. Qualitative and quantitative approaches in detecting MTS are discussed. The primary findings of vol-

ume loss as well as hyperintense signal on long TR images of the hippocampus is demonstrated. Secondary findings, including mamillary body/fornix atrophy, ipsilateral dilatation of the temporal horn and atrophy of the temporal lobe is demonstrated. The diagnosis of mesial temporal sclerosis is important, as up to 90% of patients can be cured with surgery and removal of the epileptogenic focus. The neuroradiologist is involved in evaluating lateralization of normal function and pathologic lesions prior to surgery. Indications, technique, diagnostic ramifications, and complications of the WADA test are discussed. The WADA intracarotid amobarbital test is vital in a presurgical workup to evaluate memory and speech. The expanding role of surgery, including the different types of epilepsy surgery, indications and typical postoperative images is emphasized. Potentially new imaging techniques such as surface coil high-resolution MR images, fMRI, PET, magnetoencephalography (MEG), and MR spectroscopy are discussed.

CONCLUSION

Epilepsy is a serious disorder with long-term consequences. Neuroradiologists have an emerging role to differentiate the underlying neuroanatomical substrates of epilepsy. Evaluation and lateralization of pathologic lesions as well as normal function will guide treatment and help predict prognosis. The goal of the neuroradiologist should be to provide this service more accurately and noninvasively in the future.

KEY WORDS: Epilepsy, mesial, surgery

Scientific Exhibit 16

Lesion-Induced Neurovascular Uncoupling Can Mimic Cortical Reorganization by BOLD Functional MR Imaging

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PURPOSE

Lesion-induced neurovascular uncoupling is a recognized phenomenon that may impact the accuracy of BOLD functional MR imaging (fMRI) data. The purpose of this exhibit is twofold: 1) to illustrate how lesion-induced neurovascular uncoupling along with recruitment of homologous brain regions in the contralesional hemisphere may mimic transhemispheric reorganization or dominance, and 2) to show a novel technique utilizing a visual functional field map (FFmap) to characterize neurovascular uncoupling induced by a variety of cerebral pathologies.

MATERIALS & METHODS

A retrospective review of 65 recent consecutive clinical fMRI examinations revealed 7 patients in whom the BOLD fMRI appearance of hemispheric language and motor system dominance in the contralesional hemisphere was ultimately proven to be misleading by alternative localization methods. Pathologies included gliomas (4), AVMs (2) and tumefactive encephalitis (1). Hemispheric fMRI laterality ratios were compared to actual hemispheric dominance verified by elec-

trrocortical stimulation, WADA testing, posttreatment deficits and/or lesion-induced deficits. Functional MR imaging activation maps were generated with cross-correlation ($P < 0.01$) or t-test ($P < 0.01$) analysis. For visual system pathologies, FFmaps were generated using coordinates derived from eccentricity and polar angle mapping, and the retinotopic organization of visual cortex. These maps spatially correlate discrete cortical activation areas to corresponding stimulus locations in the visual fields. By comparing FFmaps to visual field testing, the extent of neurovascular uncoupling revealed 12 additional patients with visual system pathologies including hemorrhagic cavernoma, migraines, AVMs, chronic strokes, and an arachnoid cyst.

RESULTS

Reduced fMRI signal in perilesional eloquent cortex associated with preserved or increased signal in homologous contralesional motor or language cortex suggested functional dominance opposite the side of the lesion in 7 cases, suggesting possible lesion-induced transhemispheric cortical reorganization or compensation. In three patients with left inferior frontal gyrus lesions (2 gliomas, 1 tumefactive meningoencephalitis), fMRI incorrectly suggested strong right hemispheric speech dominance. Functional MR imaging incorrectly suggested contralesional primary motor dominance in 3 patients (2 gliomas, 1 AVM) and SMA dominance in 1 patient (AVM). Pathophysiologic factors thought to have contributed to neurovascular uncoupling are illustrated in this exhibit and included direct tumor infiltration, neovascularity, cerebrovascular inflammation and AVM-induced hemodynamic effects. Of the 12 patients with lesions in the visual system where FFmap-visual field map comparisons were made, AVMs showed the greatest extent of neurovascular uncoupling. However, the neurovascular uncoupling induced by AVMs was quite variable from one patient to another.

CONCLUSION

Lesion-induced neurovascular uncoupling causing reduced fMRI signal in perilesional eloquent cortex in conjunction with normal or increased activity in homologous contralesional brain, may simulate hemispheric dominance or lesion-induced cortical reorganization. Quantifying neurovascular uncoupling using a visual system model indicates that AVMs are likely to cause neurovascular uncoupling, but that the effect is quite variable from one patient to another. Further studies are needed to determine the factors that underlie AVM and tumor-induced neurovascular uncoupling and to devise strategies to improve the accuracy of BOLD fMRI in such cases.

KEY WORDS: Neurovascular coupling, fMRI, brain lesions

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Scientific Exhibit 17

Relationship between Cortical Reorganization and White Matter Architecture Revealed Preoperatively by Functional MR Imaging and Diffusion Tensor Imaging

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PURPOSE

To demonstrate the relationship between altered cortical and white matter organization in patients with congenital brain lesions, using functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI). A secondary goal is to determine how an understanding of these relationships might enhance the prediction of functional network reorganization preoperatively in such patients.

MATERIALS & METHODS

BOLD FMRI and DTI data were obtained in 10 patients, 14 to 58 years old, with congenital brain lesions being considered for surgical management. Gray matter organization was studied with fMRI data analyzed using a cross-correlation analysis and a $p < 0.01$. White matter structure was studied using fractional anisotropy (FA) and direction-sensitive color-coded FA maps. Functional assessments were performed using superselective WADA testing in 6 patients. Lesions included AVMs (7 cases), a schizencephaly, a symptomatic atretic encephalocele, and a cavernoma. Functional systems involved that were tested with fMRI included sensori-motor, language, and visual systems.

RESULTS

In all 10 patients, the congenital lesions disrupted the normal architecture of the subcortical U-fibers. Seven of the 10 patients showed fMRI activation patterns within language, sensori-motor or visual cortex that were consistent with cortical reorganization. This was supported, though not proven, by superselective WADA testing in 5 patients. In each of the 7 patients with cortical reorganization, altered architecture of association, commissural, and/or projection white matter fasciculi and tracts were demonstrated by DTI. These were related functionally to the cortical systems mapped by fMRI. Abnormal fasciculi or tract architecture imaged included the superior longitudinal fasciculus (SLF), cingulum, corona radiata, and internal capsule, optic radiations, inferior occipito-frontal fasciculus, inferior longitudinal fasciculus, and the corpus callosum and callosal fibers. In one patient, a hematoma associated with a left superior temporal gyrus AVM caused a receptive aphasia and apraxia indicating injury to posterior language cortex and the SLF respectively, with near complete recovery. Functional MR imaging showed right hemispheric language dominance and thinning of the left SLF. In this case, the association between cortical reorganization and abnormal white matter architecture may have been from a combination of congenital and acquired effects. In two patients, a small precentral sulcus region AVM and a left middle frontal gyrus/inferior frontal sulcus cavernoma showed no associated cortical reorganization or altered fasciculi architecture. In four AVM patients, differentiating between altered hemispheric cortical organization and

the effects of neurovascular uncoupling was not possible, though the altered white matter architecture supported the suggestion of genuine cortical reorganization.

CONCLUSION

There is a high association between cortical reorganization detected with fMRI and altered architecture of major white matter bundles detected with DTI in patients with congenital brain lesions. This association may improve the accuracy of fMRI in distinguishing between genuine cortical reorganization and the effects of neurovascular uncoupling. Also, DTI in particular may be crucial in the preoperative planning of these patients, given that white matter is not accessible at most centers at this point (as is the cortex) to intraoperative mapping.

KEY WORDS: fMRI, DTI, brain reorganization

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Scientific Exhibit 18

Relationship between Contrast Enhancement and Brain Tumor Neovascularity Revealed by Blood Volume Functional Imaging

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PURPOSE

This exhibit will demonstrate the relationship between contrast enhancement and blood volume as indicators of tumor biology. Contrast enhancement is a common imaging parameter showing the breakdown of the blood-brain-barrier. It is used for presurgical planning, preradiation planning, and to identify recurrence. Blood volume is also a common imaging parameter that denotes neovascularity, irrespective of contrast enhancement. Neovascularity is a reflection of tumor growth. The relationship between these parameters has not been firmly established and could potentially lead to a greater understanding of tumor biology and extent. Our aim is to demonstrate the extent to which neovascularity is present in the absence of contrast enhancement pre and post-operatively.

MATERIALS & METHODS

To date over 300 blood volume imaging studies have been performed on patients with brain tumors. Of these, only the high-grade glioma cases will be assessed for the purposes of this study. We examined the distribution of contrast enhancement and neovascularity in 32 patients with grade III or grade IV gliomas to determine the relationship between contrast enhancement and blood volume. Blood volume maps indicate areas of neovascularity and have the potential to be used as a supplemental parameter indicating tumor extent. To obtain the blood volume maps an interleaved gradient-

echo (GE) and spin-echo (SE) imaging sequence was used. This allowed us to obtain maps of total blood volume (GE), maps primarily sensitive to microvascular blood volume (SE), and maps indicating vessel diameter (ratio).

RESULTS

All of the patients were classified by four different patterns: 1) Contrast enhancement and neovascularity correspond precisely, 2) Neovascularity is present in both contrast enhancement and nonenhancement areas, 3) Contrast enhancement and neovascularity do not correspond, and 4) There is no contrast enhancement. Of the 32 patients examined pre and post operatively, 44% showed neovascularity outside the region of contrast enhancement. In a minority of patients, neovascularity was present with little or no contrast enhancement. In some cases neovascularity was more suggestive of grade conversion than contrast enhancement.

CONCLUSION

Often there is not a good correlation between the area of contrast enhancement and neovascularity. The implications of this are that neovascularity may prove to further define the extent of the most active portions of tumor and may be predictive of recurrence before contrast enhancement is apparent.

KEY WORDS: Blood volume, neovascularity, contrast enhancement

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Scientific Exhibit 19

Multifunctional Neuroimaging: A New Approach for Assessing Brain-Related Vision Deficits

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PURPOSE

Functional MR imaging (fMRI) provides a unique opportunity to integrate structural and functional data into a comprehensive system for the diagnosis and management of brain pathology. This exhibit will review recent advances in the use of fMRI to identify and map visual cortex in patients with brain-related vision deficits. Such fMRI-based maps of normal and impaired visual function in and around a site of pathology can be helpful in planning surgery or other treatment alternatives, especially for cases in which treatment may involve the risk of further visual impairment. A novel application of the technology is to explore potential surgical scenarios and to simulate expected visual side effects for the patient. In such applications, the integrated use of structural, functional, and pathophysiologic data can provide a unique view of the relationship between a site of focal pathology

and its effect on the function of surrounding brain tissue thereby allowing more informed decisions about treatment alternatives.

MATERIALS & METHODS

The exhibit will review technologic advances in the application of fMRI for the assessment of brain-related vision pathologies and will highlight case studies that illustrate the use of the technology.

RESULTS

Techniques for mapping the cortical representations of the visual field in human patients were first developed for basic science research but have been used now with clinical patients suffering from a variety of brain pathologies. Rather than simply activating visually responsive cortical regions, these techniques provide a detailed mapping of the layout of visual space within the brain. In cases of focal brain pathology, such as retinotopic maps show the relationship between the site of pathology and the layout of visual space, especially the critical representations of foveal vs peripheral vision. Since the exact topography of these maps is unique to each individual, fMRI makes it possible to map visual function near a site of pathology on a patient-by-patient basis. By identifying which portions of the visual field are represented adjacent to a site of pathology, it is possible to predict where surgical intervention is most likely to affect vision. Since different life activities can depend more on foveal than peripheral vision (e.g., reading vs driving), the potential side effects of invasive treatment on quality of life also will be unique to each individual (e.g., librarian vs truck driver). However, the fMRI maps can be used to predict potential vision loss associated with different surgical scenarios and can be used to simulate the experience of a predicted scotoma for the patient. To date, fMRI visual field mapping has been used successfully with patients having a variety of pathologies including stroke, arteriovenous malformations, and tumors.

CONCLUSION

The technology and applications reviewed in this exhibit represent an initial “proof of concept” using a physiologic system (vision) that is easy to manipulate for purposes of development. Though the full clinical utility and prognostic capabilities of this approach have yet to be established, the concepts developed here can be extended to other systems and pathologies.

KEY WORDS: fMRI, vision, clinical

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Scientific Exhibit 20

In Vivo Detection of Apoptotic Processes by 1H MR Spectroscopy in the Brain

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PURPOSE

To demonstrate the detection of a new resonance in the brain, which may be involved in apoptotic processes. Apoptotic processes are one of two pathways of cell death. Unlike necrosis, apoptosis involves the destruction of the nuclear DNA and a blebbing of the outer cell wall. Apoptosis is known to occur in neural pruning as part of early brain development, neurodegenerative processes such as Huntington's disease, and successfully treated brain neoplasms. Staining for progenitors of apoptosis such as BAX and BCL-2 as well as staining for nuclear chromatin, which results from the nuclear laddering, demonstrates the apoptotic process in cellular culture and in animal models of neurodegenerative disease. However, apoptosis has not been detected in vivo by MR imaging nor MRS methods. If a marker of apoptotic processes were to be found, it would facilitate greatly the treatment of neurodegenerative disorders as well as improving therapy monitoring in cerebral neoplasia.

MATERIALS & METHODS

We correlated data acquired in the course of clinical MRS studies on 10 HD patients as well as treated brain neoplasm patients. In numerous cases, this data demonstrated a resonance which is situated between the choline and creatine resonance at 3.15 ppm. Unwanted and false resonances can be created by the localization processes used to acquire MRS data. To determine whether the resonance at 3.15 ppm was artifactual in nature, we analyzed data from normal volunteers and patients with untreated neoplasms of several different etiologies. To determine a possible identity for the resonance at 3.15 ppm, we have tested several candidate model compounds which have resonances in the 3.15 ppm region. Further, to investigate the reason as to why this resonance has not been reported in brain at 1.5 T, we acquired spectra from the model compounds at both 1.5 T and 0.5 T.

RESULTS

Of the model compounds tested, spermine had a resonance at 3.15 ppm which was much narrower and more detectable at 0.5 T than 1.5 T. Two patients with neoplasms that are well known to respond to radiation therapy (oligodendrogliomas) demonstrated high levels of the 3.15 ppm resonance. Both of these patients had MRS data acquired in the same locations prior to therapy, at the time of diagnosis. Neither patient demonstrated any detectable resonance at 3.15 ppm at the time of diagnosis. In a series of ten early manifest Huntington's patients, seven demonstrated the resonance. The spectra were all collected from the putamen of these patients in the course of an MRS examination. Spectra from the same patients, collected at the same sessions, but in the thalamus, did not show the 3.15 ppm resonance in any of the ten.

CONCLUSION

While the identification of the resonance at 3.15 ppm as belonging to spermine is not conclusive yet, it appears that its appearance in the spectrum correlates with processes which are known to be apoptotic in nature. Confirming the link between this observation and apoptotic activity could lead to significant improvements in therapy monitoring and therapies for the neurodegenerative diseases.

KEY WORDS: Apoptosis, spermine, neoplasm

Scientific Exhibit 21**State of the Art in the Diagnosis and Preoperative Planning of Brain Tumors**

Salvan, C. V. • Ulmer, J. L. • Prost, R. W. • Schmainda, K. M. • DeYoe, E. A. • Aralasmak, A. • Wagner, M. L. • Mueller, W. M. • Krouwer, H. G. J.

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PURPOSE

To determine the impact of integrated physiologic MR imaging techniques in the diagnosis and preoperative planning of brain tumor patients.

MATERIALS & METHODS

In addition to standard MR examinations for brain tumors, blood oxygen level dependent (BOLD) functional MR imaging (fMRI) of sensori-motor, language, and/or visual systems, diffusion tensor imaging (DTI), interleaved GE/SE relative cerebral blood volume imaging (rCBV) and MR spectroscopy (MRS) were acquired in 15 brain tumor patients, ranging in age from 20 to 64 years (7 males and 8 females). Cortex and white matter fasciculi were mapped using fMRI and DTI respectively, and correlated to pre and postoperative signs and symptoms. Tumor angiogenesis was characterized by rCBV imaging, generating maps of total and microvascular blood volume, and mean vessel diameter. Brain metabolites were assessed using MRS and 2D chemical shift imaging maps were generated to identify the distribution of metabolites. All data were integrated for the diagnosis and preoperative planning of these patients. Diagnosis was confirmed by histology in all cases. The impact of each physiologic parameter separately and together on surgical planning was determined.

RESULTS

Functional MR imaging established the relationship between brain tumor and sensori-motor, language, and/or visual cortex, as well as the lateralization of the specific brain functions. However, lesion-induced neurovascular uncoupling caused an erroneous appearance of contra-lesional hemispheric dominance in two patients. The displacement, involvement or destruction of specific white matter fasciculi, as observed in FA and color-coded maps, were considered for preoperative planning as well. The combination of fMRI and DTI data provided an opportunity to map the gray and white matter components of eloquent networks, yielding powerful information to neurosurgeons. Total and microvascular rCBV was important for the characterization of tumor angiogenesis, being predictive for tumor grade and showing

the potential risk of hemorrhagic operative complications. MR spectroscopy confirmed the diagnosis of tumor and the location and distribution of the regions of highest mitotic activity or cellular density. Imaging results correlated with the clinical postsurgical evolution of these patients. An impact on the risk assessment and/or surgical approach was most commonly seen with DTI (13 patients) and fMRI (12 patients), followed by rCBV (9 patients) and MRS (9 patients). One of the physiologic parameters was important in the risk assessment and/or surgical approach in all 15 cases.

CONCLUSION

Functional MR imaging, DTI, rCBV, and MRS are complementary and integrative in the characterization and preoperative planning of brain tumor patients, providing new information that can be used to optimize treatments and postoperative outcomes. These preliminary results illustrate the vast potential of physiologic imaging techniques for brain tumor patients.

KEY WORDS: Brain tumors, physiologic MR imaging, preoperative planning

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Scientific Exhibit 22**Anatomy, Imaging, and Lesion-Induced Functional Disturbances (Part 1) of Association and Commissural White Matter Pathways: Empowering Neuroradiologists in Clinical Scenarios**

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PURPOSE

Complex cognitive and behavioral processes are mediated by wide spread neuronal networks. The ability to identify and characterize axonal fiber bundles comprising these networks is important for understanding pathologic processes affecting higher cerebral functions. Diffusion tensor imaging (DTI) is a promising technique that has the potential to assess white matter (WM) structural integrity, directionality, and connectivity in the living human brain. Studies of neuronal connectivity are tremendously important for interpreting functional MR imaging (fMRI) data and establishing how activated foci are linked together through networks, correlating lesion localization with functional deficits, and establishing preoperative or pretreatment risks. In clinical scenarios, interpreting DTI data requires a thorough understanding of lesions effects on network functions. No such compendium exists that efficiently provides neuroradiologists the clinical understanding of functional disturbances on

a tract-by-tract basis. The aim of this exhibit is to empower neuroradiologists to fully utilize DTI data in clinical settings. The exhibit illustrates normal DTI anatomy and function of association and commissural WM fibers, and discusses the functional significance that has been established by a review of over 30 years of literature detailing lesion-induced injuries to given WM tracts.

MATERIALS & METHODS

Diffusion tensor imaging of normal subjects were performed on a 1.5 T scanner (SS-SE EPI, 6000-10000/80-85 ms TR/TE, 2 NEX, 240 mm FOV, 5 mm thickness, 25 diffusion encoding directions, $b = 1500 \text{ sec/mm}^2$). Diffusion tensor imaging data were represented as maps of fractional anisotropy (FA) and eigenvector orientation. Eigenvector orientation was assigned into red, green, and blue color channels, with color intensity modulated by FA. Artistic renditions and DTI maps were used to detail white matter anatomy, and associate imaging data with functional implications of lesion-induced injuries.

RESULTS

Three types of WM fibers most commonly recognized in the brain are association, commissural, and projection fibers. Association (intrahemispheric) and commissural (interhemispheric) fibers, which interconnect different cortical areas, make up most of the white matter of the cerebral hemispheres. Projection fibers either arise in the cortex and terminate in the subcortical centers or arise in subcortical centers and terminate in the cortex. Association fibers consist of long fibers named the superior and inferior longitudinal fasciculus, superior and inferior frontooccipital fasciculus, uncinate fasciculus, cingulum and short fibers which are the projections traveling from fasciculi into the subcortical WM. Main commissural fibers cross in the corpus callosum, the anterior commissure, and the hippocampal commissure of the fornix. Association and commissural tracts play an important role in cognitive and limbic functions including components of memory, language, motor planning, attention, and emotions. We obtained detailed DTI maps of association and commissural WM bundles in agreement with standard neuroanatomical knowledge. The functional significance of these imaged white matter tracts is discussed, using established lesion localization data.

CONCLUSION

Diffusion tensor imaging has the potential to enhance the interpretation of functional imaging studies by complementing the cortical mapping using fMRI, by adding new understanding to studies of functional neuroanatomy, and by improving our understanding of the effects of white matter structural changes induced by diseases processes. Neuroradiologists are ideally positioned to implement DTI into day-to-day clinical practice.

Part 1 of 2. See also Abstract 972.

KEY WORDS: DTI, association fibers, commissural fibers

Scientific Exhibit 23

Proton MR Spectroscopic Assessment of Brain Tumors vs Nontumorous Brain Lesions

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PURPOSE

Proton MR spectroscopy provides a chemical signature of a lesion rather than the anatomical and morphologic information obtained with standard MR imaging. The information from MR spectroscopy can be utilized to increase the specificity of a diagnosis and to help determine whether or not a lesion is a tumor. This presentation will highlight the spectrums of a variety of brain tumors and nontumorous brain lesions.

MATERIALS & METHODS

Ninety-six patients including 48 tumor cases preintervention (37 primary intraparenchymal brain tumors, 6 metastases, 5 extraaxial tumors), 27 nontumorous lesions (7 ischemic/vasculitis cases, 3 infections, 1 migrational abnormality, 3 mitochondrial diseases, 4 cases of demyelination, and 9 lesions consisting of blood/gliosis/edema) and 22 tumor patients status post intervention/treatment were reviewed. All of these patients underwent MR proton spectroscopic examinations on a 1.5 T MR unit. Single voxel spectrums were performed on a 1.5 T GE MR with Probe-P technique and a TR = 2000 ms and TE = 35 ms. Multivoxel spectrums were obtained on a 1.5 T GE CVMR with Probe-SI technique with TR = 2000 ms and TE = 35 ms. The multivoxel spectrums were analyzed on GE's Advantage Workstation 4.0 using FuncTool. The spectral peaks analyzed included lipid, lactate, N-acetyl aspartate (NAA), creatine (Cr), choline (Cho), and myoinositol. The ratios utilized to help differentiate tumor from nontumorous lesions included the Cho/Cr and NAA/Cho. The final diagnosis of the lesions was based upon pathologic analysis or clinical analysis when appropriate.

RESULTS

There are distinctive spectral patterns for brain tumors and nontumorous brain lesions. Our experience with MR spectroscopy for differentiating brain tumors and nontumorous brain lesions are illustrated. The likelihood that a lesion is a tumor is increased if the Cho:Cr ratio is >1 and/or the NAA:Cho ratio is <1 when utilizing our MR spectroscopy technique. We found it difficult to accurately differentiate demyelinating lesions from tumors with proton MR spectroscopy. The MR spectroscopy findings of gliomatosis cerebri are subtler than those seen in focal brain tumors. MR spectroscopy is useful in the posttreatment evaluation of brain tumor patients for assessing for recurrent tumor vs radiation necrosis. Multivoxel spectrums can be used to help determine if a lesion is a primary or secondary intraparenchymal tumor.

CONCLUSION

Proton MR spectroscopy provides valuable information for determining if a lesion is a brain tumor or a nontumorous brain lesion. The practicing neuroradiologist should be aware of the characteristics of brain pathologies by MR spectroscopy.

KEY WORDS: Spectroscopy, neoplasm, nonneoplastic

Scientific Exhibit 24**Short TE MR Spectroscopy of Intracranial Pathologies with Elevated Glutamate**

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PURPOSE

To demonstrate elevated glutamate and glutamine (Glx) on MR spectroscopy (MRS) in acute intracranial pathologic conditions.

MATERIALS & METHODS

Retrospective analysis of patients with abnormally elevated Glx on MRS was performed and compared to 10 normal control subjects. Examinations were performed on a 1.5 T magnet at TE values of 30 or 35 msec and alpha, beta, and gamma GLX were evaluated.

RESULTS

Elevated Glx was found in multiple conditions. Retrospective review found elevated Glx in case of acute infarction, tumors, metabolic abnormalities (hepatic encephalopathy), multiple sclerosis, trauma, and infection.

CONCLUSION

1. MR spectroscopic demonstration of elevated Glx confirms the excitotoxic theory of neuronal injury. 2. Correlation of elevated Glx with MR findings can help diagnosis in certain cases (e.g., elevated Glx helps distinguish meningioma from other extraaxial lesions). 3. Elevated Glx can help define stage of disease processes, such as in differentiating acute from chronic plaques or infarcts. It may help in defining usefulness of a particular therapy and possibly for follow-up.

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KEY WORDS: MR spectroscopy, glutamate, brain

Scientific Exhibit 25**Can In Vivo Imaging of Glutamate Predict Future Neoplasm Invasion?**

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PURPOSE

Glutamate, which is the most abundant neurotransmitter in brain, is increasingly implicated in diverse pathologies. While long known to be involved in the destruction of neurons in ischemia, glutamate recently has been shown to facilitate the spread of neoplastic glia in both neuronal culture and in an animal model. The purpose of this exhibit is to correlate, In vivo, the distribution of glutamate with the locations of recurrences in patients with high-grade gliomas.

MATERIALS & METHODS

A series of 12 patients with GBMs were examined with short echo time chemical shift proton spectroscopic imaging (2DCSI MRS) preoperatively, and glutamate/glutamine (Glx) maps were generated. Each of these patients subsequently were followed with serial gadolinium-enhanced imaging to identify the specific locations of tumor recurrences.

RESULTS

Of the twelve patients studied, the locations of elevated glutamate concentrations predicted the locations of future recurrence in 9 of the 12. These recurrences occurred within the first year following original diagnosis.

CONCLUSION

In vivo glutamate imaging may predict future recurrence and spread of high-grade gliomas. Imaging of glutamate may allow the use of adjunct therapies to inhibit the elevated glutamate exocytosis and thus slow the spread of this dread disease.

KEY WORDS: Glutamate, MR spectroscopy, glioma

Scientific Exhibit 26 (eSE)**Imaging of Glutamate In Vivo: Presymptomatic Huntington's Disease**

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PURPOSE

One of the major theories of the destruction of the striatum in Huntington's disease involves the excitotoxic glutamate activity. The excitotoxic activity of glutamate is believed to be the final common pathway in the destruction of the striatum. The destruction of the medium spiny neurons of the putamen and caudate does not become clinically manifest until approximately 75% of this neuronal population is lost. Existing therapies are insufficient due to the fact that they are not started until the clinical manifestations of the disease

are evident, which is too late for neuron sparing therapies. The detection of elevated glutamate concentrations in vivo by proton MR spectroscopy (1H-MRS) has been poorly documented and remains controversial. Three factors have led to this state of confusion. The first is the intrinsic difficulty of quantifying glutamate in spectra acquired at 1.5 T. With the potential for 3 T MRS to reveal the glutamate spectrum, there has been resurgence in interest to image this metabolite in neurodegenerative disorders. The second factor is the intrinsically poor magnetic field homogeneity obtainable in the striatum due to deposits of ferritin. The third is the relatively small increase in glutamate concentrations, relative to more acute processes such as ischemia. The decade-long course of the destruction of the striatum suggests that the elevation of glutamate concentration would not be as great as in an acute process such as seizure.

MATERIALS & METHODS

Twelve presymptomatic Huntington's patients were examined using proton MRSI on a 0.5 T system. These twelve patients all had genetic testing with CAG repeat lengths greater than 35 and a family history of HD. Additionally, ten age-matched healthy controls also were examined. All exams consisted of scout imaging, sagittal T1 and axial proton density and T2-weighted imaging. Spectroscopic imaging was accomplished with a short echo time (TE = 18ms) pulse sequence with a two-dimensional RF pulse which excited a circular disk of spins. Individual spectra were selected out of the resulting grid of spectra for quantitative analysis. Spectroscopic images also were created from data set. The data were compared to spectra obtained using long echo time (press-csi).

RESULTS

Glutamate concentrations in the putamen were significantly ($p < 0.03$ left, $p < 0.05$ right) elevated above that of age-matched healthy controls. The concentration of NAA was reduced significantly ($p < 0.05$ left, $p < 0.05$ right). When examined using the longer echo time, the changes in glutamate concentration were not significant, while the NAA concentration changes were significant. In the presymptomatic patients, the greatest increase in glutamate appears to occur in a region centered on the external capsule adjacent to the putamen, extending into the overlying cortex.

CONCLUSION

Elevated glutamate concentrations in presymptomatic Huntington's patients can be demonstrated by the use of very short echo time MRSI at 0.5 T. The detection of these elevations should lead to improved therapies to prevent the excitotoxic destruction of striatal neurons in HD.

KEY WORDS: Glutamate, Huntington's disease, MR spectroscopy

Scientific Exhibit 27

Parcellation of Cerebral Cortex Based on FLAIR Signal Intensity

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PURPOSE

Heterogeneity of intrinsic gray matter signal intensity can be demonstrated on some MR sequences, particularly FLAIR. To visualize FLAIR signal heterogeneity across the cortex and to compare this variation across subjects, we mapped FLAIR signal intensity data onto surface models obtained from coregistered T1 datasets.

MATERIALS & METHODS

Six healthy volunteers (31 ± 7 years) were imaged at 1.5 T using a quadrature head coil following informed consent under an IRB approved protocol. Cortical surfaces were extracted from two high-resolution 3D IR-GRE T1-weighted images using FreeSurfer following N3 uniformity correction and rigid coregistration. High-resolution 2D FLAIR data were obtained using 2.5 mm slice thickness covering the whole brain in 13 minutes. Five FLAIR volumes were coregistered and averaged for each volunteer. This mean FLAIR volume was rigidly registered and resectioned to match the T1 volume. For each node on the T1 surface, FLAIR signal intensity was averaged along a line segment extending between corresponding nodes on the pial and gray-white surfaces. FLAIR signal intensity was rendered onto the surface using SUMA. Brodmann areas were assigned by querying the VOTL database with node coordinates transformed into Talairach space.

RESULTS

Heterogeneity of cortical both gray and white matter was clearly evident on axial FLAIR images. Hypointense gray matter with indistinct gray white differentiation was identified in the pre and postcentral gyri, Heschl's gyrus, and a large portion of the occipital lobe corresponding to primary motor, primary sensory, primary auditory areas, and motor cortex. Pial surfaces (derived from the T1 dataset) were assigned a color scale based on FLAIR signal intensity. The pattern of FLAIR signal intensity is highly consistent across subjects. Borders between regions of differing signal intensity correspond to known borders between cortical areas. For example there is a sharp transition in signal intensity at the parietooccipital fissure. A consistent profile of differences in FLAIR signal intensity according to Brodmann area also was identified across subjects.

CONCLUSION

Mapping of FLAIR signal intensity onto surface representations of the cerebral cortex demonstrates regional differences in signal intensity across the cortex which are consistent across subjects. Presumably, this reflects intrinsic differences in cytoarchitectonic and myeloarchitectonic properties of these cortical regions indicating that FLAIR signal intensity can, to some extent, parcellate the cortex into anatomically distinct areas. Because FLAIR combines T1 effects (from inversion), T2 effects from a long TE as well as MT

effects from a long echo train, it is not clear the extent to which each of these mechanisms contributes to the differences observed. These findings motivate further research to identify the cytoarchitectonic and myeloarchitectonic features which give rise to these variations of FLAIR signal intensity.

KEY WORDS: Cytoarchitectonics

Scientific Exhibit 28

Multifunctional Neuroimaging: Using Functional MR Imaging to Map the Neural Basis of Visual, Spatial Attention

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PURPOSE

This exhibit will review recent advances in the use of functional MR imaging (fMRI) to identify and map neural mechanisms responsible for visual spatial attention in healthy individuals and, potentially, in patients with attention-related deficits. Specifically, fMRI has been used to identify and map attention-related activity within occipital visual cortex and other cortical areas of human subjects performing attention-demanding tasks. Through a unique computational technique, the resulting brain activation can be used to visualize the “window” of attention, as it would appear in the subject’s field of view. The results of this analysis provide insight into the topography of attentional selection and the neural mechanisms on which it relies.

MATERIALS & METHODS

Previously, attentional topography has been inferred from behavioral experiments or from neuroimaging brain maps (1). This exhibit will review this previous work and then describe a new technology for visualizing attentional topography as a “back-projection” of cortical activation onto a diagram of the observer’s visual field. Functional MR imaging was used to measure brain activation in subjects who were verbally cued to attend to one or more targets within a dense array of distracters. The resulting attention-related activation was then combined with data from fMRI-based visual field mapping to create a visual field map of the attentional effects.

RESULTS

Experiment 1 - Attention to a Single Target: Attentional enhancement was found to be strongest at the attended target location but spread weakly to nearby targets as well as to other distant locations in the visual field. When averaged across subjects, this pattern resembled a gradient model of attention (2) in which attentional effects gradually diminish as a function of distance from the attended target. However, individual differences suggest that this model does not explain fully attentional topography in single subjects. Experiment 2 - Attention to Targets at Different Eccentricities: Again, attentional enhancement tended to be strongest at each attended target location, though the spread of effects around the target increased with eccentricity. This spatial specificity is contrary to previous findings character-

izing attention as broadly diffuse beyond 10 degrees eccentricity (3, 4). Experiment 3 - Split Attention to Two Separated Targets. The greatest attentional enhancement was seen at the two attended target locations with a “gap” between them. Surprisingly, the attentional effects were stronger in the split condition than in the single target experiment. These results support a split or rapidly sweeping spot-light model of attention and a variable resource model (5, 6).

CONCLUSION

The work reviewed in this exhibit shows that functional imaging experiments have significantly advanced our understanding of the nature of visual, spatial attention and its underlying neural mechanisms. The results of this work establish a knowledge base and new technology that may soon be extended to clinical applications for the assessment of brain-related attentional deficits.

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KEY WORDS: fMRI, vision, clinical

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Scientific Exhibit 29

Anatomy, Imaging, and Lesion-Induced Functional Disturbances (Part 2) of Cerebral Projection and Brainstem White Matter Pathways: Empowering Neuroradiologists in Clinical Scenarios

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PURPOSE

Projection and brainstem pathways are important in the most basic of functions that are necessary for daily living. The ability to identify and characterize the axonal fiber bundles comprising these pathways is important for understanding pathologic processes affecting neurologic functions and avoiding morbidity associated with medical conditions. Directionally sensitive diffusion tensor imaging (DTI) is a promising technique that has the potential to assess white matter (WM) structural integrity, directionality, and connectivity in the living human brain. Clinical studies of white pathways are important for correlating lesion localization with functional deficits, and in establishing preoperative risks. The aim of this exhibit is to enhance the neuroradiologist’s ability to fully utilize DTI data in clinical settings, where cerebral projection and brainstem pathways are involved by disease. This exhibit efficiently illustrates normal DTI anatomy and function of cerebral projection and brainstem WM fibers, and discusses the functional signifi-

cance that has been established by a review of over 30 years of literature detailing lesion-induced WM injuries. The correlation between lesion location and functional deficits is emphasized.

MATERIALS & METHODS

Diffusion tensor imaging of normal subjects were performed on a 1.5 T scanner (SS-SE EPI, 6000-10000/80-85 ms TR/TE, 2 NEX, 240 mm FOV, 5 mm thickness, 25 diffusion encoding directions, $b = 1500 \text{ sec/mm}^2$). Diffusion tensor imaging data were represented as maps of fractional anisotropy (FA) and eigenvector orientation. Eigenvector orientation was assigned into red, green, and blue color channels, with color intensity modulated by FA. Artistic renditions and DTI maps were used to detail white matter anatomy, and associate imaging data with functional implications of lesion-induced injuries.

RESULTS

We obtained detailed WM fiber anatomy maps of normal brain and brainstem in agreement with standard neuroanatomical knowledge. Projection fibers of the brain provide connections between the cortex and subcortical centers, and can be distinguished by DTI. The internal capsule is composed of sensory thalamocortical and motor corticofugal projections within the corona radiata, forming compact anatomical WM areas including the anterior limb, genu, and posterior limb. Acoustic and optic radiations are thalamocortical sensory pathways that can be visualized and regarded as projection fibers. Visible WM tracts in the brainstem include the cerebellar peduncles, medial lemniscus, medial longitudinal fasciculus, tegmental tracts, and corticofugal fibers. We obtained detailed DTI maps of projection and brainstem WM bundles in agreement with standard neuroanatomical knowledge. The functional significance of these imaged white matter tracts is discussed, using established lesion localization data.

CONCLUSION

Diffusion tensor imaging is a new technique that enables the white matter mapping in living human brain. Complementing the cortical mapping using functional MR imaging (fMRI), it adds new understanding to functional neuroanatomy studies. The delineation of WM tracts can improve neurosurgical planning and reduce surgical risk. Depiction of WM tracts may allow the study of tumor growth patterns and increase our understanding of factors that influence functional recovery. Diffusion tensor imaging also has been used to show subtle abnormalities in neuropsychiatric and neurodegenerative diseases and could become part of routine clinical protocols for these patients as well. Neuroradiologists are ideally positioned to implement DTI into day-to-day clinical practice.

Part 2 of 2. See also Abstract 971.

KEY WORDS: DTI, projection fibers, brainstem tracts

Scientific Exhibit 30

Analysis of the Discriminatory Power of Perfusion MR Imaging and Proton Multivoxel MR Spectroscopy Compared with Conventional MR Imaging in Assessing Cerebral Tumors

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PURPOSE

MR imaging has elevated sensitivity in detecting intracranial pathologies, though poor specificity in characterizing the nature of the abnormal tissue. Tumor, radionecrosis, or post-surgical alterations may appear similar to the MR images. The association of perfusion [relative cerebral blood volume (rCBV)] and proton multivoxel spectroscopy (¹H-MRSI) has increased the specificity of MR imaging. To analyze the discriminatory power of the association rCBV/¹H-MRSI, compared to MR imaging, in the diagnosis of tumors.

MATERIALS & METHODS

Analyzed were images of 24 patients with cerebral tumors, in the Multimagem Sabin, from January to August 2003. All were examined with 1.5 T MR unit (Signa Infinity GE), ¹H-MRSI (TE = 35) and perfusion (rCBV). The images were obtained before surgery (14 patients), after treatment (9 cases), or on both occasions (1 case).

RESULTS

The pretreatment radiologic hypotheses were: glioblastoma multiforme - GBM (5 @ 33.2%), pilocytic astrocytoma (3 @ 20%), high-grade astrocytoma (2 @ 13.3%), giant cell astrocytoma (1 @ 6.7%), low-grade glioma (1 @ 6.7%), lymphoma or glioblastoma (1 @ 6.7%), hemangioblastoma (1 @ 6.7%), and meningioma (1 @ 6.7%). The radiologic diagnostic hypothesis of 10 cases examined after treatment were categorized immediately after surgery (examined at the most 10 days after surgery), or later after surgery. On patients immediately examined postsurgery (5 @ 50%), there was GBM tumor residue (3 @ 60%) and one grade II astrocytoma (20%). One case (20%), radiologically considered as free from residual tumor, was classified as a false-negative, according to an anatomopathologic assessment, for dried margins free from tumor not having been identified. For the 5 later cases (50%), the radiologic hypotheses were: recurrence of high-grade tumor in 2 cases (40%) postradiotherapy; possible recurrent tumor/gliosis in 2 patients (40%), one being postradiosurgery and the other postsurgery, besides one case (20%) of residual/recurrent meningioma.

CONCLUSION

The functional MR techniques of spectroscopy and perfusion, evaluating respectively biochemistry and cerebral microvasculature, increased the discriminatory power of MR imaging in diagnosing tumors and differentiating between recurrent/radionecrosis.

KEY WORDS: Functional imaging, neoplasms

Scientific Exhibit 31

Developing a 31P MR Spectroscopy Program: The Mayo Clinic Experience

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PURPOSE

To discuss the problems and pitfalls of developing a 31P MR spectroscopy (MRS) program at a major medical institution.

MATERIALS & METHODS

Over the past 2 years, we have attempted to get our commercial multinuclear spectroscopy package working on one of our clinical MR scanners.

RESULTS

We encountered numerous problems with our “turnkey” system. Our initial dual-tuned proton-phosphorus head coil had serious problems with the proton signal-to-noise ratio (SNR); as a result, we had to purchase a usable coil from outside. When we used the proton decoupler to improve phosphorus SNR, the SNR dropped ten-fold (rather than increase as expected); we had to install a specially designed notch filter directly into the TR switch to alleviate this problem. The system was calibrated by our service personnel to meet the vendor’s specifications; however, we were unable to adequately achieve a 90-degree flip angle. We therefore began carefully adjusting various attenuators on the RF hardware, eventually generating enough RF power to achieve a 90-degree flip angle. These problems have led to the development of a phosphorus MRS Quality Assurance program at our institution which is used routinely now to monitor scanner performance.

CONCLUSION

Despite commercially available software and coils, clinical 31P MRS remains technically challenging. Developing a successful 31P MRS program is a major undertaking, and requires extensive teamwork among clinicians, physicists, service personnel, and equipment vendors in order to obtain good quality, reliable spectra in a reasonable amount of time.

KEY WORDS: MR spectroscopy, phosphorus, technique

Scientific Exhibit 32 (eSE)

Inflammatory Myofibroblastic Tumor of the Intracranial, Head and Neck Region: CT and MR Findings in Four Cases

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PURPOSE

The purpose of this exhibit is to demonstrate CT (n = 2) and CT with MR (n = 2) findings of each case of inflammatory myofibroblastic tumors of the intracranial, head and neck region correlated with pathologic findings and review its clinical aspect.

MATERIALS & METHODS

Inflammatory myofibroblastic tumors (IMTs) generally have been termed as inflammatory pseudotumor, plasma cell granuloma, and pseudosarcomatous myofibroblastic lesion. The lesion, comprises myofibroblastic spindle cells with acute and chronic inflammatory cells, is an unusual, benign solid mass that mimics a neoplastic process. IMTs commonly affect the lung and orbit but are more rare in the head and neck, and they are encountered rarely in the paranasal sinus, larynx, oral cavity, thyroid gland, and skull base.

RESULTS

Because they mimic malignant tumors both radiologically and clinically, the radiologist should be familiar with their imaging features and help avoid unnecessary surgical procedure when possible.

CONCLUSION

We are going to introduce the pathologically proven four IMTs of the intracranial, head and neck regions. They were located in the orbit (n = 1), maxillary sinus (n = 1), supraglottic airway (n = 1), and intracranial meninges (n = 1).

KEY WORDS: Inflammatory myofibroblastic tumor, meninx, head and neck

Scientific Exhibit 33

Differential Diagnosis of Herpes Simplex Encephalitis from Its Mimics on MR Imaging

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PURPOSE

MR imaging plays an important role in the diagnosis of herpes simplex encephalitis (HSE), which frequently shows lesions in the medial temporal lobe and cingulate gyrus showing hypointensity on T1-weighted images and hyperintensity on T2-weighted images. This exhibit illustrates the spectrum of diseases that present similar MR imaging findings placing emphasis on the differential diagnosis from HSE.

MATERIALS & METHODS

From a database of MR imaging at our institution for an 8-year period, we collected cases whose differential diagnosis included HSE and reviewed their images. MR examinations in these cases included T2-weighted, FLAIR, pre and post-contrast T1-weighted imaging at 1.5 T or 0.5 T. Most patients underwent diffusion-weighted imaging as well. In cases with suspected cerebrovascular disease, 3D or 2D time-of-flight MR angiography also was obtained.

RESULTS

Cases collected included those of neoplasms (six patients with glioma, lymphoma, or brain metastasis), cerebral infarction (two patients with venous infarction due to thrombosis of the transverse sinus), head trauma (seven patients with contusion and edema), demyelinating diseases (two patients with acute disseminated encephalomyelitis), radiation necrosis (two patients), and status postepilepticus (three patients). Neoplasms and radiation necrosis in the temporal lobe resembled on precontrast images. However, they could be differentiated based on difference in patterns of contrast enhancement. Venous infarction necessitated MR venography to establish the diagnosis. Head trauma could be differentiated rather easily on the basis of clinical history as well as its cortex-dominant location. Although some lesions of acute disseminated encephalomyelitis were similar to those of HSE, lesions in other sites were a clue to the diagnosis. Lesions of status postepilepticus show hyperintensity on diffusion-weighted images in common with HSE but they are not restricted to the medial temporal lobe.

CONCLUSION

There are disorders that show similar MR imaging findings as well as clinical findings including consciousness disturbance like that in HSE. But careful image interpretation can lead to the correct diagnosis of HSE.

KEY WORDS: Herpes simplex encephalitis, MR imaging

Scientific Exhibit 34

MR Imaging of Cerebral Vasculitis

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PURPOSE

Vasculitis affecting the intracranial circulation is rare. Its diagnosis is challenging, not only because of its rarity, but also because of the lack of uniform diagnostic criteria and the difficulty in obtaining pathologic specimens from the CNS. MR imaging is considered to be an excellent screening tool for CNS vasculitis because of its reportedly high sensitivity. In this exhibit, we will illustrate various MR imaging features of cerebral vasculitis.

MATERIALS & METHODS

MR images of 12 patients with angiographically demonstrated and/or biopsy-proven cerebral vasculitis (9 women and 3 men, age 11- 57 years), were reviewed retrospectively.

RESULTS

Revealed causative pathologies of 12 cerebral vasculitis patients were fibromuscular dysplasia (1), primary angiitis of CNS (1), SLE (1), CADASIL (1), antiphospholipid antibody syndrome (1), drug (2), and idiopathic (5). The clinical presentations were motor and sensory change, blindness, dizziness, headache, change of mental status, and seizure. On MR imaging, four patients had cortical and subcortical lesions mimicking territorial infarction. Four patients had hyperintense foci at the cortex, subcortical and deep white matter, basal ganglia, and brain stem with or without adjacent meningeal thickening and enhancement. Four patients had parenchymal hemorrhage.

CONCLUSION

MR findings of cerebral vasculitis are various but they showed some patterns. We illustrate those MR imaging patterns of cerebral vasculitis with various etiologies.

KEY WORDS: Vasculitis, brain, inflammation, brain, MR imaging

Scientific Exhibit 35 (eSE)

Diffusion-Weighted Imaging Findings of Intracranial Tumors: Relationship between T2 and Diffusibility

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PURPOSE

Diffusion-weighted (DW) imaging can provide valuable information, such as tumor cellularity and grade. However, it is controversial whether DW imaging can detect tumor infiltration or differentiate the tumor type. The purpose of this exhibit is to demonstrate the findings of DW imaging in intracranial tumors.

MATERIALS & METHODS

MR examinations including DW imaging acquired in this institution from 2000 to the present were reviewed and we identified more than 500 cases of intracranial tumors. Imaging sequences evaluated were DW imaging, the apparent diffusion coefficient (ADC) maps, T2-weighted images, and postcontrast T1-weighted images. In DW imaging, a motion-probing gradient was applied in three orthogonal orientations with a b-value of 1000 sec/mm².

RESULTS

We identified a variety of intracranial tumors including low- and high-grade astrocytomas, oligodendroglioma, ependymoma, choroid plexus papilloma, ganglioglioma, dysembryoplastic neuroepithelial tumor, central neurocytoma, primitive ectodermal tumor, meningioma, hemangiopericytoma, malignant lymphoma, germ cell tumor, neurofibromatosis, craniopharyngioma, and metastases. This exhibit will demonstrate the DW appearance of these tumors comparing the effects of ADC and T2. The relationship among tumor cellularity, tumor grade, necrosis, and hemorrhage on DW imaging will be discussed also.

CONCLUSION

The interpretation of DW images requires correlation with ADC maps and T2-weighted images to understand the pathophysiologic conditions. DW imaging can provide valuable information about tumor cellularity and help in the characterization and grading of tumors of the brain. However, the ability of specific tumor differentiation and determination of tumor infiltration is difficult in most situations.

KEY WORDS: Diffusion, neoplasm, MR imaging

Scientific Exhibit 36

Physiologic Assessment of Brain Tumor Hemodynamics with Measurements of Blood Flow and Transit Time Heterogeneity

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PURPOSE

The purpose of this exhibit is to demonstrate the potential of dynamic susceptibility contrast (DSC) MR imaging to assess the functional and morphologic changes in brain tissue vasculature induced by tumor angiogenesis. Unlike other blood volume techniques, which measures neovascular morphology, this project is focused on the measurement of brain tumor hemodynamics with measurements of blood flow and transit time in addition to CBV.

MATERIALS & METHODS

In addition to conceptualizing the hemodynamic properties of brain tumors, the exhibit outlines the basis of perfusion-weighted MR imaging using susceptibility contrast agents in normal brain and tumor tissue. Postprocessing techniques to correct for contrast agent leakage and compute blood flow, blood volume, mean transit time, mean vessel diameter, and intravoxel transit time distributions are presented. The relationship between the perfusion parameters and tumor angiogenesis is characterized. The potential of this approach to improve diagnosis and aid in the optimization of treatment strategies is illustrated with clinical examples.

RESULTS

Over 200 clinical DSC MR imaging perfusion studies have been performed to date and the perfusion analysis on 28 of these has been completed. Despite the heterogeneity of tumor types, locations, classifications, and treatment protocols across the subjects several consistent features regarding the tumor perfusion have been observed. Both within and around the contrast-enhancing regions, areas of short mean transit time (MTT), high cerebral blood flow (CBF) and volume (CBV), as compared to normal brain tissue, are commonly measured. However, as you approach the center of the primary tumor mass the MTT increases while the CBF decreases. The edematous regions typically demonstrate decreased CBF and CBV but normal MTTs. In addition to the observed spatial consistencies across tumors a significant correlation between mean tumor CBF and tumor grade was found.

CONCLUSION

Dynamic susceptibility contrast MR imaging perfusion parameters have the potential to provide new insights into brain tumor hemodynamics. The spatial heterogeneity of the tumor perfusion parameters exemplify their sensitivity to angiogenic-induced hemodynamic abnormalities. The additional processing time required to compute the functional parameters (blood flow and transit time) is minimal and possibly allows the detection of regions of highest metabolic activity. This exhibit will demonstrate the clinical potential of these hemodynamic parameters for the evaluation of tumor angiogenesis and the optimization of treatment strategies.

KEY WORDS: Dynamic susceptibility contrast, tumor hemodynamics, therapy response

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Scientific Exhibit 37 (eSE)

MR Appearance of Reconstructive Flaps and Grafts in the Cranial Base

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PURPOSE

The objective of this exhibit is to promote understanding of the normal postoperative MR findings following reconstruction of the anterior and middle cranial fossa, and to highlight features differentiating these findings from recurrent tumor.

MATERIALS & METHODS

Pre and postoperative MR examinations of patients followed in the otolaryngology department after resection and reconstruction of cranial base neoplasms were reviewed retrospectively to determine a pattern in the MR characteristics of commonly used flaps and grafts. These include abdominal fat graft, skin graft, pericranial flap, temporalis muscle flap, scapular osteocutaneous flap, radial forearm fasciocutaneous flap, and rectus abdominis flap. Findings were correlated with postsurgical outcome, specifically recurrence.

RESULTS

MR characteristics were determined that allowed differentiation of flaps from grafts, evaluation of the change in flap and graft appearance over time, and discrimination of reconstructive materials from neoplasm. These patterns were influenced by the use of contrast and fat-suppression on T1-weighted images, the vascularity of components within the flap or graft, the use of reconstructive materials in addition to the flap or graft, and the enhancing characteristics of neoplasm if present. Certain normal changes were identified. Portions of a flap that are fully vascularized, such as a pericranial flap, a fasciocutaneous flap, and the muscular component of a free muscular flap, will enhance on T1-weighted images with gadolinium regardless of the use of fat saturation.

tion. However, if a fatty component is not vascularized, the use of fat-saturation after contrast enhancement will suppress the signal in this component. It was noted also that fat grafts, and nonvascularized fatty components of a muscular flap resolved over time. Additionally, the muscular component of a muscular flap showed eventual atrophy. Patterns differentiating reconstructive procedures and recurrent tumor were noticed. Recurrent neoplasm can be differentiated from the fatty, nonenhancing portion of a graft by comparison of noncontrast T1-weighted images with images postgadolinium administration and fat suppression. These sequences can show increased signal in the fatty component in the precontrast images alongside tumor, and suppressed fat alongside enhancing tumor in the postcontrast sequence. However, other postoperative complications such as fat necrosis may mimic tumor in these characteristics.

CONCLUSION

MR evaluation of the reconstructive procedures following resection of anterior skull base tumors often is confusing. However, in addition to clinical correlation and understanding of the resection techniques, knowledge of 1) the type of flap or graft used in reconstruction and their normal patterns of signal intensity, 2) the enhancing characteristics of the neoplasm, and 3) proper utilization of T1-weighted MR sequences can aid in evaluating reconstructive materials in the cranial base, and appropriately raising suspicion for complication or recurrence.

KEY WORDS: Cranial base, reconstruction, MR imaging

Scientific Exhibit 38

Differential Diagnosis of Lesions Affecting the Corpus Callosum

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PURPOSE

To show the spectrum of pathologies that may affect the corpus callosum and how this topography could help to include or exclude entities from the differential diagnosis.

MATERIALS & METHODS

We reviewed case reports from about 50 patients with affection of the corpus callosum. They had undergone CT and/or MR imaging. Some patients were referred for consultation by colleagues from other centers.

RESULTS

We found the following pathologic processes affecting the corpus callosum in our records: congenital malformations: agenesis or hypoplasia isolated or associated to many syndromes: Chiari II, lissencephaly, holoprosencephaly; vascular disease: acute or chronic ischemic lesions and hemorrhagic lesions; demyelination or inflammatory diseases: multiple sclerosis and acute disseminated encephalomyelitis (ADEM); toxic lesions: Marchiafava-Bignami disease (MBD) and antiepileptic drugs toxicity; vascular malformations: arteriovenous malformations and cavernous angioma;

traumatic disease: edematous or hemorrhagic foci of axonal injury; infectious disease: HIV encephalopathy; tumoral disease: high-grade gliomas, glioblastoma multiforme and lymphoma and psychiatric disease: we found some morphologic changes in schizophrenia and affective disorders. The characteristics and location of lesions varied with the different etiologies.

CONCLUSION

We find that lesions of the corpus callosum may be very important to orient the differential diagnosis. It is not a frequent location of any pathologic process. Even when it is not pathognomonic, the affection of the corpus callosum may suggest some etiologies upon others, depending on the characteristics of the lesion (lesions). MR images conjointly with the clinical context and other complementary tests may help to assess the diagnosis.

KEY WORDS: Corpus callosum, differential diagnosis

Scientific Exhibit 39

Contrast-Enhanced MR Angiography: Usefulness in Evaluation of the Tumor-Associated Vessels

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PURPOSE

To evaluate the usefulness of the contrast-enhanced MR angiography in evaluation of the vessels supplying and/or surrounding the tumor.

MATERIALS & METHODS

Contrast-enhanced MR angiography (MRA) was performed in 10 patients with meningiomas of the frontal cranial fossa and the parasagittal convexity, meningioma involving the cerebellopontine angle extending to the parapharyngeal space and retropharyngeal space through the jugular foramen, and paraganglioma of the jugular foramen and cerebellopontine angle. MRA was performed with 1.5 T MR machine (Signa Twinspeed, GE Medical Systems, Milwaukee, WI). Scan parameter of MRA included TR/TE = 5.5/1.5/Fr. 320 x 320 of matrix. FOV is 22 x 22. Total scan time is about 2 minutes 22 seconds. Autotriggering system was used and located in the internal carotid artery of the cavernous sinus or common carotid artery with 1 second delay. MRA was compared with postcontrast MR scans.

RESULTS

Tumor vascularity (hypervascular or hypovascular) and tumor-associated vessels such as the arteries supplying the tumor, veins draining the tumor, and adjacent compressed vessels were observed simultaneously in single examination in nine cases. These vessels were distinctly enhanced and the relationship between vessels and tumor were well demarcated.

CONCLUSION

Contrast-enhanced MR angiography is noninvasive method and is useful for simultaneous evaluation of the vessels surrounding and/or supplying the tumor as well as tumor vascularity. Therefore this examination is of help to surgeon.

KEY WORDS: MR angiography, neoplasm

Scientific Exhibit 40

Diagnostic Value of Contrast-Enhanced Fluid-Attenuated Inversion Recovery Sequence in Cranial Lesions

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PURPOSE

Fluid-attenuated inversion recovery (FLAIR) imaging of the brain has been reported to be an efficacious method for the diagnosis of several lesions including subarachnoid hemorrhage, meningoencephalitis, leptomenigeal and cranial nerve metastases, primary and metastatic parenchymal tumors, meningiomas and postoperative changes. The purpose of this exhibit is to describe and illustrate the diagnostic value of postcontrast FLAIR imaging in several cranial lesions and to compare this sequence with postcontrast T1-weighted images.

MATERIALS & METHODS

Illustrative cranial lesions including subarachnoid hemorrhage, meningoencephalitis, leptomenigeal and cranial nerve metastases, meningiomas, glial tumors, parenchymal metastases, and postoperative changes were included. Axial FLAIR and spin-echo T1-weighted imaging were obtained before and after intravenous administration of 0.1 mmol/kg gadopentetate dimeglumine in all cases. Postcontrast FLAIR images were compared with postcontrast T1-weighted images for conspicuity, contrast enhancement degree and the number of lesions. In addition, extension of the lesions were assessed also.

RESULTS

In most of the extraaxial lesions (including subarachnoid hemorrhage, meningoencephalitis, leptomenigeal and cranial nerve metastases) postcontrast FLAIR sequence was superior to postcontrast T1-weighted imaging in the number, conspicuity, and contrast enhancement degree of the lesions. Postcontrast FLAIR imaging detected a peripheral enhancement in most of the meningiomas, but was not found to be superior to T1-weighted imaging in the number, conspicuity, and contrast enhancement degree. For cerebral gliomas, postcontrast FLAIR was superior in delineating tumor extension, otherwise it did not offer any information that was not available on postcontrast T1-weighted imaging. Contrast-enhanced T1-weighted imaging was found to be superior in the number, conspicuity, and contrast enhancement degree in parenchymal metastases compared to FLAIR. Postcontrast FLAIR was found to be superior in the depiction of postop-

erative changes, and comparable in the delineation of residual enhancing lesions compared to contrast-enhanced T1-weighted imaging.

CONCLUSION

Postcontrast FLAIR sequence is a valuable adjunct to the postcontrast T1-weighted imaging. The use of FLAIR imaging routinely before and after the administration of contrast material is very efficacious in the delineation of various cranial lesions.

KEY WORDS: MR imaging, FLAIR, contrast

Scientific Exhibit 41

Comparison of Dynamic Contrast-Enhancement Patterns between Intraaxial and Extraaxial Tumors

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PURPOSE

To determine whether perfusion patterns differ between intraaxial and extraaxial tumors.

MATERIALS & METHODS

We reviewed dynamic contrast MR studies in 77 patients with intracranial tumors (40 intraaxial and 37 extraaxial). This included 25 primary brain tumors, 15 metastatic brain tumors, 28 patients with meningiomas, 2 patients with extraaxial lymphoma, 2 patients with paraganglioma and 5 patients with schwannoma. These patients all underwent echo-planar T2 dynamic contrast-enhanced 1.5 T MR imaging using spin-echo multiphase EPI (11 interleaved slices with TE = 80, a TR = 1900, FOV = 30, NEX = 1). Adequate intravenous access was obtained using a 21 gauge needle and contrast was injected at 5 cc/sec using a mechanical injector for a total volume of 0.2 mmol/kg and a maximal dose of 20 ml contrast. Acquisition time was 40 seconds with a 15 second injection delay. Relative cerebral blood volume maps were generated with the limited integration method using commercially available software. Time vs signal intensity curves were generated for each tumor and compared to normal gray matter in each patient. The overall shapes of the curves were reviewed and compared to that of gray matter. A pattern which corresponded to extraaxial tumors was identified. Two observers then reviewed the curves without looking at the images in order to differentiate intraaxial from extraaxial tumors.

RESULTS

Intraaxial tumors were found to consistently have a narrower curve than extraaxial tumors. Excellent agreement between the two observers for curve pattern was found. The extraaxial pattern was identified consistently in 26 of 28 meningiomas, 2 extraaxial lymphomas, two paragangliomas. Four of 5 patients with schwannoma displayed an intraaxial pattern of perfusion. All patients with primary tumors displayed an intraaxial pattern. Fourteen of 15 patients with metastases displayed a pattern consistent with intraaxial tumor.

CONCLUSION

Dynamic contrast-enhanced imaging may help differentiate intraaxial from extraaxial tumors in most cases.

KEY WORDS: Neoplasm, perfusion, dynamic contrast MR imaging

Scientific Exhibit 42

Characterization of Brain Tumor Neovascularity with Measurements of Total and Microvascular Blood Volume and Mean Vessel Diameter: Implications for Tumor Biology and Surgical Management

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PURPOSE

Total tumor blood volume has been shown to correlate with tumor grade (1). Here we demonstrate a multiparameter approach to simultaneously obtain information about total relative cerebral blood volume (rCBV), as well as microvascular rCBV and mean vessel diameter (mVD) in patients with brain tumors. Given that tumor vessels progress from a stage of an increased number of microvessels to fewer but larger, dilated vessels (2), this combined information should provide a more comprehensive assessment of tumor biology at its various stages of growth. Consistent with this hypothesis, the parameters obtained are predictive of tumor grade, provide information about tumor recurrence and progression, and through its ability to detect and localize the presence of large vessels, aid in the optimization of the surgical approach.

MATERIALS & METHODS

A simultaneous GE/SE echo planar imaging (EPI) sequence was used to obtain images during bolus injection (0.25 mmole/kg) of a gadolinium contrast agent. In order to diminish and correct for confounding effects from contrast agent extravasation, a preload of contrast (0.05 mmole/kg) was administered prior to the GE/SE study and a postprocessing correction algorithm applied (3). Image maps of “total” (GE) and “microvascular” (SE) rCBV are determined along with mVD, which is calculated from a ratio of GE and SE relaxation rate changes. A Spearman Rank correlation test is applied to determine the strength of the relationship between these parameters and tumor grade. Case reports are presented to demonstrate the potential of these methods to predict progression and aid in the optimization of surgical approach.

RESULTS

To date, over 300 studies using the GE/SE protocol have been performed. Of these, 45 patients with tissue confirmation of glioma, have been analyzed. When considering whole tumor, significant correlations were found between total rCBV and grade ($p = 0.001$) and mVD and grade ($p = 0.0009$), but not between microvascular rCBV ($p = 0.27$) and grade. Only when “hot spots” of microvascular rCBV are analyzed does a correlation with grade emerge. This is consistent with the standard histologic method of performing

microvessel counts from areas of vascular hot spots only. In several studies, increases in blood volume were predictive of tumor recurrence and/or grade conversion. Whether increases in total or microvascular blood volume, or both, took place seemed to be dependent on tumor stage and treatment history. Finally, maps depicting the location of large tumor vessels correspond to those observed intraoperatively.

CONCLUSION

Multiparameter blood volume imaging provides a wealth of information about the tumor neovasculature, which is not obtained with standard postcontrast MR imaging or either GE (total rCBV) and SE (microvascular rCBV) methods alone. Thus, this multiparameter approach may have a significant impact on preoperative and postoperative assessment of brain tumor biology.

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KEY WORDS: Brain tumor, physiologic imaging, functional imaging

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Scientific Exhibit 43

Radiologic Evaluation of Hydrocephalus

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PURPOSE

To describe the physiology of intracranial cerebral spinal fluid (CSF) circulation and the physiopathology of the different types of hydrocephalus together with the pertinent radiologic findings.

MATERIALS & METHODS

The physiologic mechanisms involved in the formation, resorption, and circulation of CSF within the cranium are revised together with the normal neuroimaging findings. The physiopathologic mechanism of different types of hydrocephalus is described and illustrated through a selection of representative cases studied with different neuroradiologic modalities (US, CT, and different MR techniques).

RESULTS

Advances in neuroimaging techniques have brought about a better understanding of the anatomy and physiology of hydrocephalus, which allows it to be classified according to its etiology, with evident implications for therapy and prognosis. There are essentially two main types of hydrocephalus: A) those caused by overproduction of CSF (papillomas of the coroid plexus), and B) those caused by alter-

ations in CSF circulation. This latter group can be further subdivided into 1) noncommunicating hydrocephalus, in which the causal lesion is intraventricular or due to compression from an intra or extraparenchymatous lesion, and 2) communicating hydrocephalus resulting from extraventricular obstruction secondary to a CSF resorption disorder.

CONCLUSION

Neuroimaging techniques such as CT, US in pediatric patients, and MR imaging (including cardiac-gated phase-contrast MR imaging, which are sensitive to the pulsatile movement of CSF circulation) play a vital role in the diagnosis and follow-up of hydrocephalus. The goal of neuroimaging in this context, apart from differentiating hydrocephalus from other causes of ventricular dilatation, should be to define the type and cause of hydrocephalus, as these will have important implications for prognosis and therapy. Moreover, it is essential for neuroimaging findings to be interpreted in light of the clinical history and neurologic findings.

KEY WORDS: Hydrocephalus, CT, MR imaging

Scientific Exhibit 44

Radiologic Evaluation in Follow-up and Management after Surgical Treatment of Hydrocephalus

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PURPOSE

To illustrate the neuroimaging findings in the postsurgical follow-up of hydrocephalus, emphasizing the complications that can present in association with external drainage and internal shunting.

MATERIALS & METHODS

The different surgical procedures (drainage systems, shunting devices, and ventriculostomy) used to treat hydrocephalus are described together with the radiologic techniques (US, CT, and MR imaging) used to evaluate the success of the treatment and its complications. Representative cases showing different complications occurring both within and outside the cranium are presented and analyzed by means of the relevant neuroimaging findings.

RESULTS

Common complications of surgical treatment of hydrocephalus include: a) those directly related to surgical manipulation (intracranial hemorrhage, pneumocephalus, and infections); b) those involving valvular malfunction due to obstruction or inadequate placement of the shunting device; and c) those occurring secondary to overdrainage of CSF (subdural hematomas/hygromas, intracranial hypotension, and the ventricular collapse syndrome). Other, more rare complications include those occurring in the abdomen in ventriculoperitoneal shunts and those occurring secondary to the dissemination of tumorous or infectious processes through the shunting device.

CONCLUSION

Hydrocephalus continues to pose a challenge in modern neurosurgery; its high incidence and rate of complications make reliable neuroimaging studies essential in the management and follow-up of this entity. The combined analysis of CT, US, and MR findings (including cardiac-gated phase-contrast MR imaging) gives an accurate assessment of the response to ventricular shunt placement or endoscopic procedures and is invaluable in the evaluation of complications arising after surgical treatment.

KEY WORDS: Hydrocephalus, ventricular drainage, complications

Scientific Exhibit 45

Many Faces of Meningioma

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PURPOSE

To present the various unusual and rare MR imaging findings of meningioma with pathologic correlation.

MATERIALS & METHODS

A review of our surgical pathologic record for the past 10 years revealed 328 cases of intracranial meningioma. A significant number (approximately 15%) of the cases had atypical or unusual imaging findings.

RESULTS

A total of 49 cases of meningioma was found to have atypical or unusual features, including lack of contrast enhancement, cystic/necrotic changes, intratumoral hemorrhage, two distinct areas of different signal intensity within one tumor, lytic changes of the skull with extracranial extension of the tumor, intraosseous meningioma.

CONCLUSION

Atypical and unusual MR imaging features of intracranial meningiomas are presented with pathologic correlation.

KEY WORDS: Meningioma, extraaxial tumor, brain tumor

Scientific Exhibit 46 (eSE)

Meningioma with Meningioangiomatosis: Regrowth after Partial Resection

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PURPOSE

This paper presents two cases of meningioangiomatosis with associated meningioma. Radiologically and microscopically the main differential is to distinguish it from meningioma and invasive meningioma. We present the imaging and

pathologic features of these two cases. To illustrate in one case there was partial regrowth which has not been reported in this entity.

MATERIALS & METHODS

A review of the clinical presentation, the CT, MR imaging characteristics and follow-up after surgery was done. An assessment of the role of radiology in aiding diagnosis was made.

RESULTS

Discussion of the differentials of meningioangiomatosis and the clinical presentation, imaging findings, and pathologic correlation. There was no significant characteristic to differentiate meningioangioma based on imaging findings alone.

CONCLUSION

The diagnosis of meningeal angiomatosis associated with meningioma is important because it is a benign lesion and the prognosis is excellent. There are no reported cases of recurrence; one of the cases presented showed partial regrowth following incomplete resection.

KEY WORDS: Meningioangiomatosis, regrowth, differential

Scientific Exhibit 47

Segmentation and Quantitative Analysis of the White Matter Tracts by Diffusion Tensor Imaging/Tractography

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PURPOSE

With diffusion tensor imaging and its tractography (DTT), we can segment and quantitatively evaluate the white matter tracts. With DTT, we can visualize and segment major white matter tracts. When we put the regions of interest on the segmented tracts, we can calculate diffusion tensor scalar metrics such as fractional anisotropy. Diffusion tensor anisotropic indices were reported to be useful in evaluation of the normal appearing white matter of the patients with neurodegenerative/psychiatric disorders. Those reports, however, did not use DTT for anatomical landmark in setting ROIs. We demonstrate early clinical experiences of this combined technique with validation of this method.

MATERIALS & METHODS

Forty patients with neurodegenerative/psychiatric disorders (amyotrophic lateral sclerosis: ALS and schizophrenia) and age-matched 40 volunteers were studied. Diffusion tensor imaging (TR/TE 6000/78 ms, MPG 13 axes, b-value 1000 s/mm², 128 x 128 Matrix, 2 NEX, 5 mm thickness/interleave, acquisition time 5.5 min) was performed by 1.5 T MR imager. Diffusion tensor tractography (DTT) of pyramidal tract, corticobulbar tract, fornix, cingulum and other white matter tracts were visualized by the dTV and VOLUME-ONE software (Free software by Masutani Y). After manual

selection of the slices, ROIs were semiautomatically placed on the tracts and FA and ADC within the ROIs were calculated.

RESULTS

Mean FAs of ALS patients in the ROIs along the pyramidal tract (bulbar-onset: 0.595, limb-onset: 0.587) were significantly lower than that of controls (CST: 0.639) ($p < 0.05$). Mean FA of CBT of bulbar-onset type (0.509) was significantly lower than that of limb-onset type (0.549) and that of volunteers (0.552). Mean FA of patients with schizophrenia in the ROIs along the affected tracts were significantly lower than that of controls.

CONCLUSION

There are several methods for evaluation of diffusion tensor scalar metrics. Manual ROI analysis is usually more sensitive than normalization, but it is subjective and lacks reproducibility. Our method, using the tract by DT tractography, may be an objective method for evaluation of diffusion parameters of the specific tracts. Using diffusion tensor tractography for segmentation of the white matter tracts, mean FA of the affected white matter tracts could differentiate the subtle changes between the patients and the volunteers and patient clinical subtypes.

KEY WORDS: Diffusion tensor imaging, white matter, diffusion tensor tractography

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Scientific Exhibit 48

Clinical Experience with Susceptibility-Weighted Neuroimaging

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PURPOSE

To summarize the current clinical experience with susceptibility-weighted imaging (SWI) in the evaluation of brain masses, CVA, trauma, and occult vascular disease.

MATERIALS & METHODS

Susceptibility-weighted imaging is a high-resolution, three-dimensional, fully velocity compensated gradient-echo sequence. Postprocessing is applied using both magnitude and phase images to increase the conspicuity of the veins and other sources of susceptibility effects (1). This sequence, used at multiple centers nationwide, has been applied to over 44 patients with brain masses, 7 pediatric patients with trauma (2), and multiple patients with CVA and occult vascular lesions such as AVMs and capillary telangiectasis. Comparison to conventional imaging sequences (T1, T1 postcontrast, T2, proton density, FLAIR and/or diffusion-weighted imaging) was made for all cases.

RESULTS

The identification of local changes in blood volume, venous drainage and hemorrhage all affect the interpretation of brain lesions in MR imaging. Susceptibility-weighted imaging is suited uniquely for the visualization of blood products, with consequent relevance for the detection of hemorrhage in trauma and CVA. Susceptibility-weighted imaging provides complementary information to conventional imaging sequences for the analysis of internal composition of brain masses, and is superior to other sequences for the visualization of small venous structures both within masses and vascular malformations.

CONCLUSION

Susceptibility-weighted imaging is a vital adjunct for improving the diagnosis and characterization of brain masses, trauma, occult vascular malformations, and hemorrhagic CVA, by virtue of its ability to show venous vasculature and blood products better than any other sequence.

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KEY WORDS: Susceptibility-weighted imaging, BOLD, review

Scientific Exhibit 50**Evaluation of Cavernous Sinus Lesions with Sixteen-Row Multidetector CT**

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PURPOSE

To review the anatomy and radiographic spectrum of cavernous sinus lesions, emphasizing an approach, radiologic mimics, and key differentiating points. We stress the utility and emerging role of 16-row multidetector CT in the diagnosis and management of cavernous sinus pathology.

MATERIALS & METHODS

A 0.5 second rotation 16-slice helical CT (Somatom Sensation, Siemens) was used. Three-dimensional reconstructions and two-dimensional reformatted images were generated from the axial images at the workstation. We reviewed the imaging studies and clinical features of patients who presented with cavernous sinus lesions. Correlation with MR imaging/angiography, with FLAIR and diffusion-weighted imaging, as well as conventional angiography, was performed when applicable.

RESULTS

Cavernous sinus lesions may be related to inherent neural and vascular structures, arise within the cavernous sinus itself, or result from extension of local or distant disease processes. Neoplastic entities include cranial nerve schwannoma, meningioma, hematogenous extracranial metastasis, parasellar dermoid, and local contiguous invasion by aggressive pituitary macroadenoma or chordoma. Vascular lesions are aneurysms of the cavernous portion of the internal carotid artery, carotid-cavernous fistula and dural AVF, and venous thrombosis. Infectious entities, such as invasive aspergillosis, inflammatory and granulomatous processes, such as sarcoid, may involve the cranial nerves, or they may extend from the basilar cisterns (meningitis) and the sphenoid sinus.

CONCLUSION

Sixteen-row multidetector CT can improve visualization and understanding of cavernous sinus pathology. Awareness of the normal anatomy of the cavernous sinus and familiarity with distinguishing imaging features of assorted lesions can help the radiologist achieve a prompt and accurate diagnosis.

KEY WORDS: Multidetector CT, cavernous sinus

Scientific Exhibit 51**Three-Dimensional Digital Angiography and Fusion Digital Subtraction Angiography: Two New Reconstruction Algorithms for Simultaneous Three-Dimensional Rendering of Osseous and Vascular Information Obtained during Rotational Angiography. Technical Aspect and Clinical Application**

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PURPOSE

To describe and illustrate the clinical value of two reconstruction algorithms providing simultaneous three-dimensional imaging of bone and blood vessels.

MATERIALS & METHODS

Two algorithms that can build three-dimensional vascular and osseous data sets from standard catheter rotational angiograms are described: (1) Three-dimensional digital angiography (3D DA) reconstructs a nonsubtracted angiogram in a single three-dimensional representation of the blood vessels and surrounding bony structures; (2) Three-dimensional fusion digital angiography (3D FD SA) is based on separate reconstructions of the mask and contrast sequences of the rotational acquisition. The two independent three-dimensional data sets (3D bone and 3D DSA) are then fused in a single three-dimensional representation. Both algorithms use a modification of the Feldkamp method that compensate for the signal inhomogeneity inherent to the reconstruction of nonsubtracted rotational acquisitions. The three-dimensional data set is postprocessed using a commercially available computer workstation. The rotational data sets were obtained as part of routine diagnostic cerebral angiography. The parameters used for rotational angiogra-

phy were as follows: tube rotation 200 degrees at 40 degrees/sec, frame rate 30 frames/sec. The contrast volumes (in ml) and rates (in ml/sec) were as follows: vertebral artery (18/3), common carotid artery (24/4), internal carotid artery (18/3). For each patient, 3D DA and/or 3D FDSA was obtained in addition to standard 3D DSA using the same rotational data set. Three-dimensional digital angiography is illustrated with three clinical cases (posterior fossa arteriovenous malformation, skull base arteriovenous fistula, intrasellar aneurysm). Three-dimensional digital angiography is illustrated with three clinical cases (giant skull base aneurysm, suboccipital venous varix and neuralgia, and lesser sphenoid wing meningioma).

RESULTS

Both algorithms successfully build three-dimensional data sets that combine vascular and osseous information. Three-dimensional digital angiography allows evaluating the topographic relationships between the blood vessels and their bony surroundings. However, since 3D DA is based on the reconstruction of a single nonsubtracted rotational data set, it cannot avoid an artifactual loss of image quality when osseous and vascular structures are immediately adjacent, such as at the skull base. Three-dimensional fusion digital angiography separately reconstructs the osseous and vascular information obtained from the rotational angiogram, keeping optimal angiographic resolution and offering precise topographic analysis even when vessels are in contact with bone. The additional information brought by 3D DA and 3D FDSA was useful for: 1) the establishment of a topographic diagnosis (e.g., suboccipital varix and neuralgia), 2) the documentation of unsuspected lesion extension (e.g., skull base aneurysm eroding into the posterior fossa), 3) the planning of surgical intervention (e.g., lesser sphenoid wing meningioma). Three-dimensional fusion digital angiography was superior to 3D DA in the analysis of skull base lesions, where it could show fine topographic relationships between the blood vessels and the adjacent bone without the artifacts and loss of image quality seen with 3D DA.

CONCLUSION

We report two reconstruction algorithms that offer simultaneous three-dimensional display of the osseous and vascular information obtained by rotational catheter angiography. Both 3D DA and 3D FDSA provide clinically useful topographic information through simultaneous three-dimensional representation of vascular and osseous structures. Three-dimensional fusion digital angiography is superior to 3D DA for the imaging of skull base vascular lesions.

KEY WORDS: Three-dimensional angiography, cerebrovascular diseases

The authors of this work have indicated the following affiliations/disclosures: Toshiba Medical Systems: Employee.

Scientific Exhibit 52

Near-Infrared Monitoring of Tissue Oxygenation during Diagnostic and Interventional Cerebral Angiography

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PURPOSE

Near-infrared spectroscopy (NIRS) is a technique that is capable of noninvasive and continuous monitoring of the state of oxygenated hemoglobin (OHb) and deoxygenated hemoglobin (DHb) in tissue in vivo. The aim of this exhibit was to demonstrate temporary changes of cerebral oxygenation during diagnostic cerebral angiography and internal carotid artery balloon occlusion test by NIRS.

MATERIALS & METHODS

The optrodes of a near-infrared spectrometer (Noninvasive Oxygenation Monitor OM-200, Shimadzu, Japan) were positioned on the lateral frontal surface of the patient's forehead. Near-infrared spectroscopy measurements of OHb, DHb, and THb were made during the ipsilateral internal carotid artery balloon occlusion of 15 minutes. The sensitive volume of the NIRS detector was situated within about 4 centimeters depth from the surface. The sampling time for each photon count was 1 to 5 seconds. The relative percentage changes of OHb, DHb, and THb concentrations were calculated. One hundred three measurements were performed during the ipsilateral internal or common carotid diagnostic angiography using nonionic contrast media. The injection of the nonionic contrast media ranged from 6 to 11 ml in volume and 2 to 7 ml/sec in injection speed. Next, 18 patients were examined with temporary balloon test occlusion of the internal carotid artery and NIRS for preoperative evaluation of adequate collateral circulation. In 15 of the 18 patients, brain SPECT during the balloon test occlusion was employed also and compared with NIRS. 99mTc-HMPAO was injected intravenously after the balloon occlusion of 3 minutes.

RESULTS

In 102 of the 103 measurements during the diagnostic angiography, OHb and THb decreased temporarily and DHb increased during the transition of contrast media. In one measurement, no significant changes could be detected due to very high cerebral blood flows induced from the large frontal AVM. Each maximum relative change of OHb, DHb, THb, and SdO₂ (= DHb/THb%) were -16.46% +/- 11.43, 3.71% +/- 3.67, -11.35% +/- 7.69, and -6.50% +/- 6.55 (mean +/- SD%). In two patients of the 18 with the test occlusion, neurologic deficits were presented and the test was stopped. In 16 patients, no neurologic deficits were presented during the test occlusion. In 14 of the 16 patients, NIRS demonstrated a transient decrease in OHb and an increase in DHb, indicating the absence of severe hypoxia in the ipsilateral hemisphere from inadequate collateral circulation. The relative changes of OHb and DHb were -22.05 and 17.22 (mean) %, respectively. Brain SPECT showed decrease of regional cerebral blood flow (rCBF) of frontal lobe, but the degree was under 15% in comparison with the opposite side. In the other two patients, NIRS showed no

decrease in OHb. The relative changes of OHb and DHb were 1.87 and 2.12 (mean) %, respectively. Brain SPECT showed no significant decrease of rCBF.

CONCLUSION

Near-infrared spectroscopy was able to monitor the temporary changes of cerebral oxygenation during diagnostic and interventional cerebral angiography. Further study of this procedure may provide more information with respect to regional cerebral blood flow and tissue oxygenation.

KEY WORDS: Near-infrared monitoring, cerebral angiography, interventional

Scientific Exhibit 53

Diffusion-Weighted Imaging of Acute Excitotoxic Brain Injury

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PURPOSE

To demonstrate diffusion-weighted (DW) imaging of acute excitotoxic brain injury and its pathophysiology. Trans-synaptic injury via excitotoxic amines such as glutamate is a specific type of injury in the peripheral and central nervous system. Recent studies show that receptors related to excitotoxic mechanisms are distributed widely in the brain, not only in the gray matter (neurons) but also in the white matter (astrocytes and oligodendrocytes). Excitotoxic brain injury is presumed to be related to any pathologic condition that causes cytotoxic edema, resulting in decreased ADC.

MATERIALS & METHODS

We reviewed over 200 cases that include infarction, hypoxic ischemic encephalopathy (HIE), the early phase of wallerian and transneuronal degeneration, status epilepticus, corpus callosum lesion related to seizures or antiepileptic drugs, diffuse axonal injury, cortical contusion, shaken baby syndrome, the acute phase of multiple sclerosis, toxic and metabolic leukoencephalopathy, osmotic myelinolysis, and Creutzfeldt-Jakob disease (CJD).

RESULTS

Energy failure is an initial insult in infarction or HIE, and impaired reuptake of glutamate usually causing severe excitotoxic brain injury, mostly resulting in necrosis and atrophy. Distribution of HIE and secondary degeneration from ischemia could be related to excitotoxic circuits via synapses or axons. Excessive release of glutamate can cause cytotoxic edema in seizure, infection, demyelination, or toxic metabolic disease. Such cytotoxic edema is due to excitotoxic injury with less energy failure, and could be reversible. In status epilepticus, the distribution of DW abnormalities in the hippocampi, thalami, and cerebral cortices could be related to that of NMDA receptors. Leakage of glutamate can cause traumatic brain injury. The severity and distribution in HIE, shaken baby syndrome, and neonatal herpes encephalitis seems to be related to the vulnerability to excitotoxic injury in neonates and infants. Structurally similar substance

is seen in organic acid disorders which also cause excitotoxic injury. Receptor dysfunction occurs in some metabolic (phenylketonuria) and degenerative diseases (CJD), resulting in excitotoxic brain injury.

CONCLUSION

Diffusion-weighted imaging is useful in evaluating cytotoxic edema due to excitotoxic brain injury. The severity (reversibility) and distribution are different in various diseases (cell types, initial insults, and their mechanisms) and in patient's age (distribution of receptors, maturity of blood-brain barrier). Glutamate receptor antagonists will offer attractive possibilities for future therapy as a neuroprotectants in these diseases.

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KEY WORDS: Diffusion-weighted imaging, MR imaging, excitotoxic

Scientific Exhibit 54

Can Multislice CT Angiography Contribute to the Diagnosis and Evaluation of Dissected Craniocervical Arteries?

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PURPOSE

To evaluate the ability of multislice CT angiography (MCTA) to detect and diagnose dissection of carotid and vertebral arteries.

MATERIALS & METHODS

Twelve dissected craniocervical arteries were diagnosed in 11 of 204 consecutive patients who underwent multislice CTA of the craniocervical arteries in our department. There were 6 males and 5 females, 8-74 years of age. Indications for MCTA were as follows: penetrating cervical trauma (5), acute spontaneous SAH (2), CVA (3), and suspected aortic dissection (1). The imaged volume extended from the aortic arch level to a level above the circle of Willis. Diagnosis was confirmed with MR imaging, DSA or surgery. MR studies were performed on a 0.5 T Gyrex MR imaging system (Elscent) and 1.5 T Echospeed system (GE). DSA studies were performed with a Multistar system (Siemens).

RESULTS

Seven dissections of the carotid arteries were found in six patients. In three patients, the dissection was located at the cervical segment of the internal carotid artery (ICA); in two patients it was at the carotid siphon and, in the sixth patient, bilateral dissections of the common carotid arteries were demonstrated. Dissected vertebral arteries were diagnosed in four patients: at C1-2 level in two, at C3 level in one, and at the intracranial segment in the fourth. A dissecting aneurysm of the right PICA was demonstrated in one patient. In 10 patients, the diagnosis was confirmed by DSA, MR imaging or at surgery. In all cases, MCTA demonstrated the narrowed arterial lumen and pointed to the exact location of the dissection. Intramural hematomas indicating extension of the dissected segment were demonstrated only in affected carotid arteries and could not be seen in dissected vertebral arteries.

CONCLUSION

Multislice CT angiography may be a valuable tool for the detection and evaluation of dissected carotid and vertebral arteries. It is more informative in carotid dissections and may contribute to diagnostic and therapeutic cerebral angiogram planning, as well as for treatment decision-making in these patients.

KEY WORDS: Arterial dissection, CT angiography, cranio-cervical arteries

Scientific Exhibit 55

Subtraction Three-Dimensional CT Angiography Using Multidetector Row CT with Controlled-Orbit Helical Scanning: Application to the Evaluation of Postoperative Intracranial Aneurysms

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PURPOSE

Our goal was to evaluate the utility of subtraction three-dimensional (3D) CT angiography using multidetector row CT with newly devised controlled-orbit helical scanning in the postoperative intracranial aneurysms.

MATERIALS & METHODS

One hundred twenty patients (136 aneurysms) performed a clipping operation for aneurysms and were examined using multidetector row CT with controlled-orbit helical scanning. Multidetector row CT scanner was Aquilion Multi (4-detector rows and 16-detector rows, Toshiba, Japan). The scan parameters in 4-detector rows CT scanner were as follows: high voltage 120 kV, tube current 300 mA, slice collimation 4 x 0.5 mm, rotation time 0.75 sec, CT pitch factor 0.75:1 (helical pitch 3:4). The scan parameters in 16-detector rows CT scanner were as follows: high voltage 120 kV, tube current 300 mA, slice collimation 16 x 0.5 mm, rotation time 1.0 sec, CT pitch factor 0.6875:1 (helical pitch 11:16). The contrast medium (Iohexol 350 mgI/ml) was injected via antecubital vein at the rate of 1.5-2.0 ml/sec with power injector. The total volume of contrast medium was 1.2-1.5

ml/body weight kg. The 0.5 mm-thick axial images were reconstructed at every 0.2 mm interval. The 3D reconstruction was performed using volume-rendering method on a workstation (Zio M900 Quadra, Ziosoft Inc., Japan). Subtraction 3D CT angiograms were compared with 3D CT angiograms for their characterization of postoperative intracranial aneurysms.

RESULTS

Three-dimensional CT angiograms could depict the postoperative state of intracranial aneurysms with titanium clips to some extent. Three-dimensional CT angiograms could not depict the postoperative state of intracranial aneurysms with cobalt clips due to their severe artifacts. Subtraction 3D CT angiograms with fusion of clips could clearly depict the relation between the clips and neck of aneurysms in all intracranial aneurysms with clips except 8 cases with poor subtraction images due to severe motion artifact. Subtraction 3D CT angiograms were superior to 3D CT angiograms in the depiction of postoperative state of all intracranial aneurysms. Subtraction 3D CT angiograms could clearly depict 6 remnant necks of aneurysms and 6 residual aneurysms. In the follow-up examinations of a partially thrombosed giant aneurysm after clipping operation, subtraction 3D CT angiograms with fusion of clips and thrombus clearly could depict complete thrombosis and volume loss of aneurysm.

CONCLUSION

Subtraction 3D CT angiography using multidetector row CT with controlled-orbit helical scanning was effective in the depiction of postoperative state of intracranial aneurysms.

KEY WORDS: Multidetector row CT, CT angiography, intracranial aneurysm

Scientific Exhibit 56

Evolution of Radiosurgical Planning for Treatment of Cerebral Arteriovenous Malformation: Current Experience with Multimodal Target Characterization Based on CT Angiography and Digital Subtraction Angiography

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PURPOSE

To review the history of imaging in target characterization for radiosurgical treatment of cerebral arteriovenous malformations (AVM), and to describe a methodology currently used at our institution.

MATERIALS & METHODS

The history and evolution of radiosurgical planning is discussed through a review of the literature and clinical experience at University of Southern California over the past two decades.

RESULTS

The precise three-dimensional definition of the nidus of a cerebral AVM in space has been problematic since the inception of radiosurgical techniques for treatment. The pitfalls

that limit the effectiveness of *all* techniques employed to date for this purpose for the most part fall into one of three categories: inaccurate 3D characterization of the lesion; magnification distortion of cut film and digital subtraction angiograms (DSA); and absence of hemodynamic information with rotational 3D DSA, MR imaging, MRA, and CTA. Some of the various methods that have been devised to compensate for these shortcomings are reviewed, all of which involve some degree of compromise from an idealized target volume characterization. Most methods involve the use of multiple imaging modalities that complement one another. The development of rapid multislice CT scanners capable of acquisitions with near-isotropic voxel parameters allows the acquisitions of highly spatially detailed CT angiograms that can be used in conjunction with the Cyberknife[®] radiosurgery system. Our early experience with the combined use of CT angiography and DSA for Cyberknife[®] treatment planning of cerebral AVM is described.

CONCLUSION

Optimal radiosurgical planning for treatment of cerebral AVM is challenging due to limitations of current imaging methodologies. However, advancements in imaging technologies, particularly when used in combination, have at least partially overcome many of the obstacles to accurate lesion characterization. We describe our early experience with a multimodality approach using CT angiography and DSA with the Cyberknife[®] radiosurgery system.

KEY WORDS: Arteriovenous malformation, radiosurgery, Cyberknife

Scientific Exhibit 57

Contrast-Enhanced MR Venography of the Brain

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PURPOSE

To illustrate the advantages of bolus gadolinium contrast-enhanced MR venography (CE MRV) of the brain.

MATERIALS & METHODS

A bolus gadolinium MRV pulse sequence using elliptic centric phase-encoding order was implemented for use on both 1.5 T and 3.0 T clinical MR imaging units. Contrast-enhanced MRV studies were obtained in 75 patients referred for imaging of suspected venous pathology. Most patients also underwent conventional MRV using 2D TOF and/or 2D PC MRV at the same imaging session.

RESULTS

Contrast-enhanced MRV is a robust technique which may be implemented readily on a clinical MR imaging unit. Contrast-enhanced MRV acquisitions are shorter than conventional 2D TOF MRV, and cine PC MRV, with the additional advantage of providing entire brain coverage. Contrast-enhanced MRV allows depiction of very small venous structures which are usually beyond resolution available with our current 2D TOF and 2D PC protocols. Contrast-enhanced MRV is significantly ($p < 0.05$) less prone

to false-positive results than 2D TOF and 2D PC. Contrast-enhanced MRV also is superior to these other techniques for depicting complete and partial dural venous-sinus thrombosis, arteriovenous malformations, and infarction.

CONCLUSION

Contrast-enhanced MR venography is likely to become the new MR imaging-based "gold standard" for evaluation of the dural sinuses and veins of the brain.

KEY WORDS: MR venography, dural venous sinuses

Scientific Exhibit 58

Variabilities of Cerebral Arteries: Normal Variant and Anomalous Vessels

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PURPOSE

To demonstrate variable angiographic findings of normal variants and anomalous vessels on cerebral angiography with reference to origin and clinical significance.

MATERIALS & METHODS

We retrospectively reviewed 920 cases with digital subtraction cerebral angiography who underwent cerebral angiography for various causes of cerebral ischemia, subarachnoid hemorrhage, AVMs, and brain tumors.

RESULTS

This exhibit includes: 1) fenestration of supraclinoid portion of ICA, vertebral artery, basilar artery, and ACA; 2) accessory and duplicated MCA; 3) cerebellar artery originating from the ICA; 4) duplicated posterior communicating artery (variant territory of anterior choroidal artery); 5) cortical variations of ACA (azygos artery variants, triplicated artery, accessory ACA or median artery of corpus callosum, and bihemispheric type of ACA); 6) variable branching patterns of MCA (a single trunk with no main division, bifurcation, trifurcation, and quadrifurcation); 7) variables in the posterior circulation (duplicated SCA, SCA originate from P1 of PCA, duplicated AICA, triplicated AICA, common trunk of AICA and PICA, parieto-occipital and calcarine artery from ACA, and extracranial PICA); 8) a nonbifurcating cervical carotid artery.

CONCLUSION

Familiarity with these anomalous vessels of cerebral arterial system is essential to the proper surgical treatment of cerebral aneurysm, understanding the collateral blood supply in cerebral ischemia, and to endovascular approach to cerebral AVMs.

KEY WORDS: Cerebral artery, normal variant, anomalous vessel

Scientific Exhibit 59 (eSE)

Diffusion-Weighted Imaging Findings of Intracranial Hemorrhage

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PURPOSE

Diffusion-weighted (DW) imaging is often of limited value for diagnosis and staging of intracranial hemorrhages; however, understandings of DW imaging characteristics are important to avoid misinterpretations. The purpose of this exhibit is to demonstrate the appearance of hematomas and to discuss the effects of T2, magnetic susceptibility, and diffusibility on DW images.

MATERIALS & METHODS

MR examinations acquired in this institution from 2000 to the present were reviewed and we identified more than 200 cases of intracranial hematomas. Imaging sequences evaluated were DW imaging, the apparent diffusion coefficient (ADC) maps, T1- and T2-weighted images. Additionally, gradient-echo sequences also were obtained. In DW imaging, a motion-probing gradient was applied in three orthogonal orientations with a b-value of 1000 sec/mm².

RESULTS

Intracranial hemorrhages are often characterized as to their location, such as intraparenchymal, subarachnoid, subdural, epidural and intraventricular hemorrhages. The etiology of these hemorrhages includes a variety of heterogeneous conditions such as trauma, hypertension, infarction, infection, neoplasm, vascular malformations, vasculitis, vasculopathy, coagulopathy, and drugs. This exhibit will illustrate DW imaging characteristics of intracranial hemorrhages in relation to their location, etiology, and evolutionary stage.

CONCLUSION

Apparent diffusion coefficient measurements of intracranial hemorrhages might be problematic and are only possible in the hyperacute stage which contains diamagnetic oxy-hemoglobin and in the late subacute phase which contains extracellular met-hemoglobin whose paramagnetic susceptibility artifacts were diminished by the dilution of the fluid. CT and routine MR imaging continue to be the mainstay in diagnosing and characterizing intracranial hemorrhages. However, understandings of DW imaging characteristics are important in order to avoid inaccurate conclusions.

KEY WORDS: Diffusion, hemorrhage, MR imaging

Scientific Exhibit 60

Imaging Studies in the Evaluation of Carotid Cavernous Sinus Fistulas

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PURPOSE

Carotid cavernous sinus fistulas (CCF) may arise from the ICA itself or meningeal branches of both ICA and ECA. It is classified as direct and indirect type CCF according to the communication of fistula. Since CCF is a diverse and often complex group of vascular disorders, complete and accurate imaging study is essential for the strategy of treatment. In this study, we will discuss the pathology of CCF and the value of both CT angiography (CTA) and MR angiography (MRA), comparing with the digital subtraction angiography (DSA), in the evaluation of arteriovenous communication of fistula, venous drainage, and other vascular condition.

MATERIALS & METHODS

Sixty-seven patients, 16 to 71 years old, with clinical manifestations of pulsatile exophthalmos, chemosis, and bruit were enrolled in this study. The pre and postcontrast-enhanced CT were done in all patients, and CTA was performed in 54 cases (46 direct, 8 indirect). The spin-echo T1 and T2 MR imaging and 3D TOF MRA were done in 64 patients (43 direct, 21 indirect) and contrast-enhanced MRA (CE MRA), 54 cases (33 direct, 21 indirect). These findings then were correlated to DSA (46 direct, 21 indirect) and were used as guide to treatment. The findings of concern included: the feeding arteries of fistula, size and location of fistula tract, cavernous sinus pattern, dilatation of ophthalmic vein, pattern of venous sinus drainage, engorged pial-cortical vein and/or deep vein drainage, venous aneurysm and/or venous sinus varix formation, arteries dissection.

RESULTS

Direct CCF was diagnosed in 46 patients and indirect CCF was diagnosed in 21 patients. In direct CCFs, the ICAs were obscured rapidly by the dilated cavernous sinus in both CTA and MRA, while in indirect CCFs, ICAs can be detected only in MRA with mild obliteration. In both direct and indirect CCFs, the dilated cavernous sinus, venous drainage, and venous aneurysm formation were demonstrated readily by CTA and MRA studies (80-96%). From the source imaging of CTA and MRA in direct CCFs, the location and size of connecting fistula tracts between ICA and engorged cavernous sinuses could be identified (81-91%) and were further confirmed by DSA procedure (93%). In the indirect CCFs, the feeding arteries can be found in more than half of cases by the MRA. The venous aneurysms were found about 15-17% in direct CCF patient by all imaging studies.

CONCLUSION

Both CTA and MRA images are helpful in the diagnosis of direct CCFs, whereas MRA is more useful in the detection of indirect CCFs. The venous drainage and aneurysm formation are demonstrated in all imaging studies. Moreover, the source image of CTA and 3D TOF MRA are valuable tools in the identification of size and location of fistula shunt which is crucial in the preembolization assessment, with the CTA imaging somewhat superior.

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KEY WORDS: Carotid cavernous sinus fistula, CT angiography, MR angiography

Scientific Exhibit 61

CT Angiography in the Evaluation of Subarachnoid Hemorrhage: Before, After or in Lieu of Catheter Angiography?

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PURPOSE

Cerebral catheter angiography (CCA) is still considered to be the “gold standard” in the evaluation of nontraumatic subarachnoid hemorrhage (NTSAH). However, the increasing availability of multislice CT scanners and refinement of imaging protocols has made cerebral CT angiography (CCTA) a reasonable alternative, and in some institutions, has replaced CCA in the initial evaluation of NTSAH. Additionally, because CT allows for evaluation of extraluminal structures, pathology detection is not limited to the flow of contrast within the lumen and the likelihood of demonstrating pathology adjacent to a vessel is increased. To determine the role of CCTA in the initial evaluation of patients presenting with NTSAH and whether or not it can temporize, complement or even replace CCA in certain clinical situations.

MATERIALS & METHODS

A number of patients were selected retrospectively and prospectively, all having undergone CCTA and CCA within 1 week of presentation. Each examination was screened by two attending neuroradiologists and a neuroradiology fellow. The CCTA was deemed successful when the results concurred with those of the CCA, and superior when findings were made only on the CCTA.

RESULTS

Cerebral CT angiography uncovered pathology not demonstrated on the CCA in a number of patients, particularly in the setting of aneurysm thrombosis and back-wall aneurysms.

CONCLUSION

In the evaluation of NTSAH, CCTA is a valuable tool and a reasonable alternative to CCA. In some instances, particularly when a three-dimensional angiography suite is not available, it can uncover pathology not demonstrated on CCA.

KEY WORDS: CT angiography, subarachnoid hemorrhage, aneurysm

Scientific Exhibit 62

Choroid Plexus: A Pictorial Essay from Normal Anatomy to Pathology

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PURPOSE

To review the embryology and normal anatomy of the choroid plexus with special attention paid to their vascular anatomy. The authors also illustrate the imaging appearance and discuss the differential diagnosis of choroid plexus pathologic processes.

MATERIALS & METHODS

Normal anatomy of the choroid plexus was reviewed from anatomical dissections of human cadavers and imaging studies (DSA and MR imaging). Normal variants and pathologic processes of the choroid plexus, especially tumors and vascular malformations, were analyzed based on the embryology and normal anatomy.

RESULTS

Choroid plexus are extremely vascularized structures with a vital role in the cerebrospinal fluid dynamics.

CONCLUSION

Choroid plexus anatomy and embryology knowledge facilitates the understanding of the variants and pathology of these structures.

KEY WORDS: Choroid plexus, choroid arteries, anatomy

Scientific Exhibit 63 (eSE)

MR Imaging and MR Angiography of the Hypoglossal Artery

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PURPOSE

To demonstrate the imaging findings of the hypoglossal artery on MR imaging and MR angiography (MRA) and to understand the embryology of persistent carotid-vertebral fetal connections.

MATERIALS & METHODS

MR imaging and MRA studies in five patients with a hypoglossal artery are reviewed to demonstrate the typical anatomical findings. Correlation is made with embryology, anatomical drawings, and imaging studies of cases of persistent trigeminal artery, otic artery, and proatlantal intersegmental artery.

RESULTS

The presence of the hypoglossal artery is identified on both brain MRA and head and neck MRA. Depending on the field of view chosen, identification of the entire course may require both brain and head and neck MRA.

CONCLUSION

The hypoglossal artery can be identified on MRA studies of both the brain and of the head and neck. Complete visualization often requires both studies. Routine brain MR images occasionally demonstrate the hypoglossal artery. The hypoglossal artery can be differentiated from other fetal carotid-vertebral connections.

KEY WORDS: Vascular variants, persistent fetal connections, hypoglossal artery

Scientific Exhibit 64

Vascular Lesions of the Temporal Bone: Avoiding Misdiagnosis

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PURPOSE

Vascular temporal bone lesions are uncommon, but of critical importance to the surgeon. We present a spectrum of vascular lesions involving the temporal bone on CT or MR imaging in order to enhance recognition of these abnormalities and discuss entities with which these lesions may be confused.

MATERIALS & METHODS

A series of cases of vascular lesions involving the temporal bones was collected over several years. Patients were evaluated with CT, MR imaging, or catheter angiography.

RESULTS

We present a spectrum of vascular lesions of the temporal bone, including aberrant carotid artery, persistent stapodial artery, glomus tympanicum, dehiscence jugular bulb, dural arteriovenous fistula (AVF), hemangioma, and anterior inferior cerebellar artery aneurysm. We discuss the imaging features of these lesions, and compare and contrast their imaging findings with those of lesions commonly confused with vascular lesions.

CONCLUSION

Vascular lesions of the temporal bone are unusual, but extremely important entities to recognize in order to avert serious morbidity.

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KEY WORDS: Vascular, temporal bone

Scientific Exhibit 65

Anatomical Variations of the Superficial Middle Cerebral Vein; Embryologic Aspects of the Regressed Embryonic Tentorial Sinus: Preliminary Results

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PURPOSE

The embryonic tentorial sinus usually regressed during post-natal development; however, its typical prenatal drainage patterns and intradural anastomoses can be depicted as various developmental phenotypic representations. Here, we tried to clarify the variant types of the superficial middle cerebral vein (SMCV) upon the relationship with embryonic tentorial sinus.

MATERIALS & METHODS

Total 41 patients and 82 hemispheres were included in this study. CT angiography was performed in all patients for the screening methods of cerebrovascular disease or other intracranial disorders. Separate workstation and 3D software were used to evaluate the cranial venous systems with 3D volume-rendering techniques, thin-slice MIP images, and MPR techniques for the analysis of its complicated angioarchitecture. Variations of the SMCV were classified according to the developmental alterations of embryonic tentorial sinus, including sphenoparietal sinus (cranial remnant of tentorial sinus), basal sinus (floor of middle cranial fossa), petrosal diploic, and caudal remnant of the transverse sinus. Secondary intradural anastomoses of cavernous and superior petrosal sinuses were evaluated also for the efferent pathways.

RESULTS

The most frequent type of remnant tentorial sinus, sphenoparietal sinus was present in 49% (40/82) of examined hemispheres. Other regressed patterns of embryonic tentorial sinus were identified also in 38% (31/82); 9 caudal remnant type around the transverse sinus, 10 petrosal diploic and caudal type, 2 petrosal diploic type, 1 basal type, unclassified 5 (2 of them have the efferent toward medial and lateral tentorial sinus), and any combination of above lists were found in 4 cases. Secondary intradural, cavernous sinus anastomosis was seen in 44% (36/82); however, more prevalent pattern was no anastomosis (46/82) with cavernous

sinus. Only one case of superior petrosal sinus anastomosis was found in this series associated with basal type (formerly described as “sphenotemporal sinus” by Padget DH).

CONCLUSION

Anatomical variations of SMCV can be demonstrated clearly with embryologic aspects of the tentorial sinus according to its developmental regression and postnatal secondary adaptations of cerebral venous drainage.

KEY WORDS: Embryonic tentorial sinus, superficial middle cerebral vein, cerebral venous system

Scientific Exhibit 66

Anatomical Variations of the Deep Cerebral Veins, Tributaries of Basal Vein of Rosenthal; Embryologic Aspects of the Regressed Embryonic Tentorial Sinus: Preliminary Results

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PURPOSE

Embryonic tentorial sinus regresses at the 60-80 mm embryologic stage and most of deep venous channels constitute the basal vein of Rosenthal (BVR). Persistent remnants of embryonic tentorial sinus can be seen in adult configuration of BVR. We tried to explain the anatomical representations of the BVR associated with the remnant embryonic tentorial sinus.

MATERIALS & METHODS

Total 41 patients and 82 hemispheres were included in this study. CT angiography was performed in all patients for the screening methods of cerebrovascular disease or other intracranial disorders. Separate workstation and 3D software were used to evaluate the cranial deep venous systems with 3D volume-rendering techniques, thin-slice MIP images, and MPR techniques for the analysis of complicated angioarchitecture. Variations of the BVR were classified according to the developmental alterations of efferent pathways into 4 groups; telencephalic group (A) included tributaries of uncus vein, inferior frontal vein, anterior communicating vein, and inferior striatal vein, diencephalic group (B) of inferior ventricular vein and peduncular vein, tegmental bridging group (C) of longitudinal LMV anastomosis, tectal group (D) of superior vermian vein and internal occipital vein relation to the Galenic connection. The BVR constituted from embryonic tentorial sinus was also assessed and the developmental aspects were reviewed.

RESULTS

Remnant embryonic tentorial sinus was visualized in 12% (10/82) of hemispheres, all of them invariably connected with telencephalic (A) and diencephalic (B) groups. Most of those connections (9/10) to basal venous tributaries were originated from medial tentorial sinus except one case from lateral tentorial sinus. No Galenic connections of the BVR were identified in 10% (8/82). Various tributaries of the BVR were classified as: Telencephalic group (A) 43% (35/82), Diencephalic group (B) 35% (29/82), Bridging group (C)

11% (9/82), and Tectal group (D) 6% (5/82). Three of cases (4%) were nonclassified and then revealed only small basal tributaries of BVR without connection to the great vein of Galen.

CONCLUSION

Anatomical variations of the BVR connected with persisted embryonic tentorial sinus often could be demonstrated in adult configurations considering the embryologic aspects of developmental regression and secondary cerebral venous adaptations.

KEY WORDS: Embryonic tentorial sinus, basal vein of Rosenthal, cerebral venous system

Head & Neck 67-84

Scientific Exhibit 67

Ligaments of the Cranio-Vertebral Junction

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PURPOSE

The purpose of this exhibit is to discuss the ligamentous anatomy of the cranio-vertebral junction from a neuroradiologist's perspective and to demonstrate the various ligaments with different imaging modalities. Thin section CT and high-resolution MR studies allow visualization of most of these ligaments.

MATERIALS & METHODS

We will demonstrate the normal cranio-vertebral ligaments using sketch diagrams, and MR and CT images from normal subjects. Imaging of patients with cranio-vertebral junction abnormalities will be incorporated also from our imaging database to enhance the description.

RESULTS

Complex sets of ligaments connect skull base, atlas and axis vertebrae. They are broadly classified as follows: 1. Articulation of the Atlas with the Occipital Bone - a) Capsular Ligaments: Two capsular ligaments connect the occipital condyles with the superior articular process of the atlas. b) Anterior Atlanto-Occipital Ligament: It extends as a broad band of densely woven fibers, connecting the anterior inferior margin of the foramen magnum to the upper border of the anterior atlantal arch. c) Posterior atlanto-Occipital Ligament: It connects the posterior margin of the foramen magnum to the upper border of the posterior atlantal arch. d) Lateral Atlanto-Occipital Ligaments: They extend from the jugular tubercle of the occipital bone to the bases of the transverse process of the atlas. 2. Articulation of the Atlas with the Axis - a) Capsular Ligaments: Connects the lateral mass of the atlas to the superior facet of the axis. b) Anterior Atlanto-Axial Ligament: It connects the inferior border of the anterior arch of atlas to the ventral surface of the body of

the axis and later continues as the anterior longitudinal ligament. c) Posterior Atlanto-Axial Ligament: It is a thin membrane attached to the inferior border of the posterior arch of the atlas to the superior edge of the lamina of the axis. d) Transverse Ligament: Thick strong ligament retains the dens in contact with the anterior arch of the atlas and is attached on either side to small tubercles on the medial surface of the lateral mass of the atlas. e) Cruciform Ligament: Superior and the inferior crus of the transverse ligament extend superiorly and inferiorly in the midline and form the cruciate ligaments. The superior crus is attached to the basiocciput and the inferior crus is attached to the posterior surface of the body of the axis. 3. Ligaments Connecting the Axis with the Occipital Bone - a) Tectorial Membrane: Strong band of ligament inside the vertebral canal connects the dorsal surface of the axis to the basilar groove of the occipital bone. b) Alar Ligaments: They are two strong round cord-like structures extending obliquely from the cranial part of the dens to the rough depressions on the medial aspect of the occipital bone. c) Apical Ligament: It extends from the tip of the odontoid process to the anterior margin of foramen magnum.

CONCLUSION

We present an overview of the normal ligamentous anatomy of the cranio-vertebral junction with the goal of improving detection of the abnormalities involving these significant "stabilizing forces."

KEY WORDS: Cranio- vertebral junction, ligaments

Scientific Exhibit 68

CT and MR Imaging Findings of Kimura Disease in the Head and Neck

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PURPOSE

To evaluate CT and MR imaging findings of Kimura disease in the head and neck.

MATERIALS & METHODS

CT (n = 18) and MR (n = 6) images obtained in 22 patients (18 men and 4 women; mean age, 36 years; age range, 9-62 years) with histologically proved Kimura disease in the head and neck were reviewed retrospectively. All patients presented with a palpable mass(es) in the head and neck with a duration ranging from 2 months to 25 years (mean, 7.6 years). Diagnosis was confirmed by excisional biopsy including partial parotidectomy in 21 patients and fine needle aspiration biopsy in one patient. Two patients had another mass in the forearm, which also proved to be Kimura disease. We analyzed the imaging findings with particular attention to the multiplicity, location, size, margin, and enhancement pattern of the lesion. The signal intensity of the lesion seen on MR images as well as the presence or absence of lymphadenopathy were recorded also.

RESULTS

CT and MR images demonstrated multiple lesions in 19 patients and solitary lesion in the remaining three patients. The periparotid region was the most common head and neck location involved by Kimura disease seen in 16 patients. Other sites of involvement in decreasing order were the parotid gland (n = 9), temple (n = 2), submental space (n = 2), lacrimal gland (n = 2), buccal space (n = 1), and scalp (n = 1). Thirteen patients had cervical lymphadenopathy, which accompanied the main lesion(s) in 12 patients. In the remaining one patient, lymphadenopathy was the isolated abnormality on imaging. The greatest diameter of the lesions measured 1-8 cm with a mean of 3.3 cm. The lesions were well demarcated in nine patients and poorly demarcated in six patients. In seven patients, the coexistent well and poorly demarcated lesions were noted on CT and MR images. All lesions enhanced well on contrast-enhanced CT and MR images. MR imaging obtained in six patients showed various signal intensity of the lesions, reflecting varied amounts of fibrosis and vascular stroma contained in the individual lesion at histologic examination. Compared to the cerebral gray matter, the lesions were hyperintense in two patients and hypointense in four patients on T1-weighted imaging, and hyperintense in three patients, isointense in two patients, and hyperintense in one patient on T2-weighted imaging.

CONCLUSION

Multiple, well enhancing masses located at the periparotid or intraparotid region with or without lymphadenopathy were the most common CT and MR imaging findings of Kimura disease in the head and neck. MR imaging also showed various signal intensity of the lesions, which correlated histologically to varied amounts of fibrosis and vascular stroma.

KEY WORDS: Kimura disease, head and neck, MR imaging, CT

Scientific Exhibit 69

Spectrum of Imaging Findings of the Parotid Tumors and Tumor-Like Lesions

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PURPOSE

Parotid tumors are uncommon neoplasms that account for about 3% of all head and neck tumors. The imaging features of parotid tumors have been reported. However, only a few reports exist in which the imaging-pathologic correlation is described in detail. The purpose of this study is to describe the imaging findings of parotid tumors with pathologic correlation. Furthermore we illustrate imaging findings of parotid tumor-like lesions in the differential diagnosis.

MATERIALS & METHODS

We reviewed 140 cases of the parotid tumors and tumor-like lesions collected between January 1992 and December 2003 from our pathology consultation files. All tumors were surgically resected and histologically verified. Sufficient imag-

ing was available in 113 patients with 134 parotid lesions (27 malignant tumors and 106 benign tumors or tumor-like lesions).

RESULTS

Most of pleomorphic adenomas were characterized by bright signal intensity (SI) on T2-weighted imaging and marked enhancement at around 120-150 seconds. Those areas corresponded to fibromyxoid stroma pathologically. Solid component of Warthin's tumors (adenolymphoma) showed rapid enhancement/washout pattern on dynamic study. Sometimes Warthin's tumors were seen as almost cystic lesion. Large cystic area was seen in lymphoepithelial cysts, Warthin's tumors (cystic type), and degenerative change in other tumors including basal cell adenomas and pleomorphic adenoma. Multiple lesions and/or bilateral lesions were highly suspected Warthin's tumor or malignant lymphoma. 99mTc scintigram was useful to differentiate Warthin's tumor and oncocytoma from other tumors or tumor-like lesions. 67Ga scintigram showed high accumulation in the tumors of malignant lymphoma, carcinomas, pleomorphic adenoma and inflammatory diseases, which could not differentiate between the benign and malignant lesions. High-grade malignant tumors had infiltrative margins with lower SI than normal parotid gland on T2-weighted imaging. In contrast, low-grade malignant tumors had the smooth margin. The characteristic low-grade mucoepidermoid carcinomas had multiple high SI areas on both T1-weighted and T2-weighted images. These areas corresponded to mucinous cysts pathologically. The low-grade adenoid cystic carcinoma were characterized by high SI on T2-weighted imaging and marked enhancement. These findings corresponded to cribriform arrangement containing mucinous fluid.

CONCLUSION

MR images and 99mTc scintigrams are helpful in differentiating benign and malignant tumors of the parotid gland, and can provide important clues in the diagnosis of their histologies.

KEY WORDS: Parotid gland, MR imaging, neoplasm

Scientific Exhibit 70 (eSE)

Acinic Cell Carcinoma of the Head and Neck: Imaging Findings with Pathologic Correlation

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PURPOSE

Acinic cell carcinoma (ACC) is a rare salivary gland tumor accounting for 2.5-5% of all parotid epithelial neoplasms. Furthermore, the report of imaging findings of the ACC involving other sites of the head and neck is extremely rare. The purpose of this exhibit is to describe the CT and MR imaging features and pathologic correlation of the ACC in the head and neck.

MATERIALS & METHODS

We illustrate the radiologic findings of 12 patients with pathologically proven ACC in the head and neck for 10 years. They were six males and six females (ages: 5-75 years, mean 36 years) who underwent CT (n = 10) and CT with MR imaging (n = 2).

RESULTS

The locations of the tumor were the parotid gland (n = 9), parapharyngeal space (n = 1), submandibular gland (n = 1), and palate (n = 1). The CT findings of the tumor were solid mass (n = 7), cystic mass (n = 3) and cystic mass with mural nodule (n = 2). The parotid tumors were solid (n = 7), cystic (n = 1), and cystic mass with mural nodule (n = 1). A parapharyngeal lesion was cystic mass with mural nodule and a submandibular and a palate tumors were cystic lesions. All solid masses in parotid gland (n = 7) included focal low attenuating portions on CT, which were microcyst, hemorrhage, or necrosis on pathologic examination. The MR findings of two lesions were cystic mass with mural nodule and solid and cystic mass, respectively and showed internal hemorrhage, which was not discernible on the CT image. There was no evidence of lymph node metastases on pathologic examination.

CONCLUSION

Although acinic cell carcinoma is a rare and challenging tumor to radiologist and pathologist due to its nonspecific imaging findings and variable pathologic findings, familiarity with imaging findings of acinic cell carcinoma can be helpful for differential diagnosis of the salivary gland or head and neck tumors.

KEY WORDS: Acinic cell carcinoma, salivary gland, CT and MR imaging

Scientific Exhibit 71 (eSE)

Spectrum of Metastatic Renal Cell Carcinoma to the Head and Neck

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PURPOSE

To demonstrate the spectrum of renal cell carcinoma (RCC) metastases to the head and neck, ranging from the common sites in the brain parenchyma and spine to the less common sites such as pituitary gland, choroid plexus, paranasal sinuses, and thyroid.

MATERIALS & METHODS

A group of 139 patients with the diagnosis of RCC who had imaging of the head and neck with either CT or MR imaging between 2000 and the present (2003) were reviewed. Approximately 30% of patients had metastatic disease to the head and neck—8% to the neck, 19% to the brain, and 3% to the head (not to brain parenchyma). Ten cases were selected from these 30% of patients with metastatic RCC to illustrate the range of presentations of head and neck spread of tumor.

RESULTS

Ten cases with CT and/or MR imaging are presented, all with known metastatic RCC. Cases include metastases to the paranasal sinuses, nasal cavity, choroid plexus, pituitary gland, sella with cavernous sinus invasion, scalp, thyroid, supraclavicular lymph nodes, cervical spine, and brain parenchyma with intraventricular bleed due to hemorrhagic metastasis.

CONCLUSION

Renal cell carcinoma accounts for approximately 3% of visceral malignancies and has a propensity for metastatic spread, most commonly to infraclavicular sites such as lung, liver, regional lymph nodes, and bone. Supraclavicular spread of tumor occurs less commonly, reported to occur in up to 8-15% of patients with RCC. Of infraclavicular primary malignancies, only lung and breast cancers spread more often above the level of the clavicles. It is estimated that about 8% of patients with RCC will present initially with symptomatic head and neck metastases before the primary tumor is discovered. Our case reports demonstrate the recognized tendency of RCC to go to the sinonasal region and thyroid and the tendency toward hemorrhagic metastases. Additional cases present less frequently described sites of spread of RCC, such as to the pituitary. These cases are intended to serve as a reminder that when tumor is identified in the head and neck, while both supra and infraclavicular primary tumors will be considered, that RCC is among the leading infraclavicular tumors to spread to this region.

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KEY WORDS: Renal cell carcinoma, metastases, head

Scientific Exhibit 72

Clival Chordoma: A Radiologic Survey of Atypical Cases and Mimics

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PURPOSE

To illustrate the diverse radiologic spectrum of clival chordoma, emphasizing its unusual radiologic appearances. Mimics and key distinguishing differential features are discussed.

MATERIALS & METHODS

We retrospectively reviewed the CT and MR imaging studies of patients with biopsy-proven chordoma performed during the past 9 years at our institution. We evaluated both atypical skull base chordomas presenting as other entities as well as lesions which simulated clival chordomas.

RESULTS

Chordomas that extend primarily anterior to the clivus may masquerade as nasopharyngeal lesions. One case we present was considered initially to be squamous cell carcinoma. Chordomas with posterior spread, on the other hand, may invade the basilar cisterns. We demonstrate an unusual example of a chordoma encasing the basilar artery, mimicking an epidermoid tumor. A wide array of tumors and tumor-like conditions, as well as inflammatory processes which involve the clivus and paraclival structures, can resemble chordomas. Tumors of the skull base include both primary neoplasms, such as meningiomas and chondrosarcomas, and metastases. We illustrate a rare case of clival hamartoma. Infections and inflammatory processes encompass bacterial osteomyelitis and erosive invasive fungal sinus disease. Medial petrous apicitis, associated with Gradenigo's syndrome, atypically can produce clival erosion. Rheumatoid pannus formation also may alter the normal clival appearance. Sellar lesions invading the skull base include aggressive pituitary macroadenoma.

CONCLUSION

Clival chordomas may have uncommon presentations. An awareness of helpful distinguishing characteristics, such as central location, bone destruction and calcification, may help alert the radiologist to the possibility of this uncommon neoplasm even if it occurs in an improbable location.

KEY WORDS: Chordoma, clivus

Scientific Exhibit 73

It's Not Always Salt and Pepper: A Comprehensive Review of Typical and Atypical Paragangliomas and their Mimics

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PURPOSE

Paragangliomas are uncommon, highly vascular tumors that arise from the paraganglion cells of the parasympathetic nervous system.

MATERIALS & METHODS

These tumors typically demonstrate characteristic features, including flow voids and a "salt-and-pepper" appearance on MR imaging, although the latter is not always seen. They may be found in typical locations such as the parapharyngeal space (glomus vagale), the skull base and middle ear (glomus jugulare, tympanicum, and jugulotympanicum), and in the region of the carotid bulb (carotid body tumors). When

found in these locations, with specific imaging characteristics, the diagnosis is usually not in question. However, in ectopic locations, or if atypical features are present, these lesions may present a diagnostic challenge.

RESULTS

To date we have identified six nonfamilial paragangliomas in several ectopic locations. These include two lesions within the parasellar region, one in the pterygopalatine fossa, two within the nasal cavity, and a paraganglioma of the facial nerve.

CONCLUSION

In this exhibit, we review the clinical and imaging findings from our large collection of paragangliomas in "classic" locations on CT, MR imaging, CTA, MRA, and catheter angiography, and present our six paragangliomas arising in ectopic locations. Mimics that may cause diagnostic confusion when evaluating either "classic" or "ectopic" paragangliomas (e.g. nasal cavity haemangiomas/schwannomas, skull base metastases, carotid space neurogenic tumors, pterygopalatine fossa juvenile angiofibromas, etc.) are included.

KEY WORDS: Paragangliomas, typical, atypical

Scientific Exhibit 74

Ear, Nose, and Throat Pathology in AIDS

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With the development of new and more effective medication regimens, the incidence of routine paranasal sinus infection in patients with AIDS has decreased. The purpose of this exhibit is to present a spectrum of other pathology that can occur in the head and neck in the setting of AIDS. These include fungal infections, TB and MAI, lymphoma, Kaposi sarcoma, parotid lesions, and infections of the temporal bone. The radiologic appearance, pathologic features, and clinical presentation will be described.

KEY WORDS: AIDS, ENT, pathology

Scientific Exhibit 75

Vascular Lesions of the Orbit: More than Meets the Eye

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PURPOSE

As a group, vascular lesions of the orbit are uncommon, and some are rare. There is confusion regarding their nature and controversy regarding their nomenclature and classification. Therefore, when encountered, they often present a diagnostic dilemma.

MATERIALS & METHODS

For the purposes of this exhibit, these lesions can be classified, based upon their natural history and histology, as follows: *Primary Lesions*: 1. hemangiomas; 2. vascular malformations - a. capillary, b. venous - cavernous malformations and orbital varix, c. lymphatic - capillary and cavernous, d. arteriovenous - AVM, including Wyburn-Mason syndrome; 3. aneurysms of the ophthalmic artery; 4. tumors - hemangioblastomas, hemangioendotheliomas, hemangiopericytomas and metastases. *Secondary Lesions*: 1. carotid cavernous fistulas - a. direct type, b. indirect type.

RESULTS

We have accumulated multiple examples of the above lesions from a review of the teaching files at several institutions.

CONCLUSION

In this exhibit, we present the clinical findings, natural history, imaging features (CT, MR imaging and angiography), and histopathology of these uncommon and rare lesions. Key findings that help differentiate these lesions from one another are highlighted (the utility of delayed imaging in confirming the diagnosis of cavernous vascular malformations, usefulness of various provocative maneuvers in demonstrating orbital varices, etc.).

KEY WORDS: Orbit, vascular, lesions

Scientific Exhibit 76

Brachial Plexus: Anatomy, Pathology, and Optimal Imaging

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PURPOSE

The brachial plexus arises from the lower cervical and upper thoracic spinal nerve roots, coursing between the anterior and middle scalene muscles and adjacent to the subclavian artery. Clinical features of brachial plexopathy are commonly nonlocalizing, often vague, and frequently nonspecific. Patients vary in their presentation depending upon the extent, degree, and duration of injury. Symptoms include motor, sensory, and sometimes, autonomic disturbances of the supraclavicular region, shoulder, and upper extremity. These symptoms may be exacerbated by certain arm and shoulder positions. Occasionally, these findings also may be associated with tenderness or with a palpable abnormality above the clavicle. Traumatic injuries and involvement by tumors account for the majority of etiologies responsible for these plexopathies, but inflammatory/infectious processes also can involve the brachial plexus.

MATERIALS & METHODS

The data base of medical imaging procedures at the University of Michigan was searched to identify all brachial plexus MR and CT myelographic examinations performed between June 2000 and December 2003. The results of this search then were reviewed and stratified into traumatic, neo-

plastic, and infectious/inflammatory processes. Multiple representative images from each category then were identified and photographed.

RESULTS

The course of the brachial plexus can be identified with knowledge of certain anatomical landmarks which are seen readily on cross-sectional imaging studies. The supraclavicular plexus (roots, trunks) is located between the anterior and middle scalene muscles, while the retroclavicular (divisions) and infraclavicular (cords) course adjacent to the subclavian artery. The plexus may be visualized with both MR imaging and CT myelography, each modality having distinct advantages for the evaluation of specific lesions. CT myelography is the modality of choice for evaluating patients with post-traumatic plexopathy, while MR imaging should be performed in patients with neoplastic or inflammatory/infectious etiologies. In particular, coronal and sagittal MR sequences can be extremely helpful in characterizing brachial plexus pathology and aiding surgeons with their preoperative planning.

CONCLUSION

The brachial plexus can be imaged successfully with both MR and CT myelography. While MR excels in the evaluation of neoplastic and inflammatory/infectious etiologies, CT myelography is the modality of choice for the evaluation of posttraumatic injuries.

KEY WORDS: Brachial plexus

Scientific Exhibit 78 (eSE)

Unusual Imaging Manifestations of Thyroid-Associated Orbitopathy and Its Mimics

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PURPOSE

To illustrate both usual and unusual manifestations of thyroid-associated orbitopathy (TAO) as well as other lesions of the extraocular muscles that mimic TAO.

MATERIALS & METHODS

We performed a retrospective analysis of all lesions that enlarged the extraocular muscles on CT and MR imaging during the past 2 years at our institution. We correlated imaging characteristics to clinical and pathologic findings.

RESULTS

Thyroid-associated orbitopathy (TAO) has well described effects on the four rectus muscles. However, TAO also can uncommonly affect the levator palpebrae superioris, and the superior and inferior oblique muscles. The various methods of assessing enlarged extraocular muscles on CT, MR imaging, and ultrasound are reviewed briefly. Quantitative analysis is limited greatly by the wide range of normal measurements. The enlarged extraocular muscle bellies in TAO can be mimicked by metastatic lesions, lymphoma, and rare tumors such as extramedullary plasmacytoma. Metastatic

lesions that we encountered include lung carcinoma, squamous cell carcinoma, and carcinoid. If the belly and tendon are both involved, pseudotumor is favored. Infectious and granulomatous myositis also can enlarge the extraocular muscles.

CONCLUSION

Thyroid-associated orbitopathy can have unusual manifestations and can be mimicked by a variety of different lesions including metastasis, lymphoma, plasmacytoma, pseudotumor, and infectious or granulomatous myositis.

KEY WORDS: Ophthalmopathy, thyroid associated orbitopathy, extraocular muscles

Scientific Exhibit 79

Moved to POSTER 100A

Intraorbital Vascular Anomalies: A Pictorial Review

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PURPOSE

To provide a pictorial review of the most common and uncommon intraorbital vascular lesions.

MATERIALS & METHODS

A review of the imaging characteristics of a large number of intraorbital vascular lesions, as they relate to the anatomy and pathology of the particular entity. The cases have been collected over the past several years at our two major affiliated hospitals at William Beaumont.

RESULTS

Discussion of multiple intraorbital vascular lesions includes but is not limited to retinal angioma, lymphangioma, capillary hemangioma, hemangioma of infancy, venous varix, superior ophthalmic vein thrombosis, carotid cavernous fistula, and hemangiopericytoma.

CONCLUSION

Information provided through this presentation will enable the reader to recognize and easily diagnose vascular lesions of the orbit.

KEY WORDS: Orbit, vascular lesions

Scientific Exhibit 80

Perineural Invasion of Xth Cranial Nerve by Squamous Cell Cancers of Oral Cavity/Oropharynx: Review of Three Cases

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PURPOSE

Perineural spread is observed most commonly with adenoid cystic carcinomas and squamous cell cancers of head and neck, although a number of other malignant and benign lesions also can spread through this route. Recognition of this process is important for appropriate management and to avoid delayed recurrence. Maxillary and mandibular branches of the trigeminal nerve and the facial nerve are involved most commonly by perineural cancer spread. To the best of our knowledge, imaging features of perineural spread along Xth nerve have not been reported previously. In this exhibit, we will present representative cases of histologically proven infiltration of the Xth nerve.

MATERIALS & METHODS

Three cases of histologically confirmed perineural infiltration of Xth cranial nerve were found in the teaching database of one of the authors (SKM). The clinical and imaging features of these cases were reviewed.

RESULTS

All three patients had recurrent oral cavity/oropharyngeal cancers. None of the patients exhibited signs or symptoms of cranial nerve X dysfunction. On imaging, perineural infiltration was seen as tumor extending along the carotid sheath. Partial or complete encasement of internal carotid artery was seen in all patients. In all cases, the perineural spread was not suspected on the initial imaging study and was diagnosed on surgery/histologic examination.

CONCLUSION

Cranial nerve X infiltration can be seen with oral cavity/oropharyngeal cancers. On cross-sectional imaging studies, tumor can be seen extending along the carotid sheath with partial or complete encasement of internal carotid artery. Therefore, patients exhibiting this finding should be suspected of having perineural spread along the cranial nerve X. Entire course of Xth nerve should be examined in these patients, preferably with MR imaging.

KEY WORDS: Perineural spread, vagus nerve, MR imaging

Scientific Exhibit 81

Multicystic Encephalomalacia

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PURPOSE

To evaluate the various neuroradiologic appearances of multicystic encephalomalacia (MEM). To analyze the etiopathology and the neurologic outcome.

MATERIALS & METHODS

We retrospectively analyzed 58 children diagnosed with MEM in our hospital between 1982-2003. Ultrasound (43 cases), CT (37 cases), and MR imaging (17 cases) were the imaging techniques utilized.

RESULTS

The imaging findings vary depending on the time passed between the ischemic insult and the date of the examination. Edema that progressed to multicystic parenchymal transformation is the rule. In the late stages there is ex vacuo lateral ventricles dilatation and enlargement of the extraaxial compartment. In some cases, a complete absence of brain mantle is present, like in hydranencephaly. Thalamic and infratentorial structures frequently are preserved. Etiologic factors: in 23 cases there were multiple pregnancies with intrauterine co-twin death; 13 cases meningitis/sepsis; 9 acute fetal distress; 6 multi-etiological shock; 2 thrombotic cerebrovascular accident; 5 unknown. Neurologic outcome depended on the necrosis extension and/or the location of the affected area.

CONCLUSION

Multicystic encephalomalacia is an infrequent pediatric entity. The brain tissues suffer variable, often extensive, ischemic destructive damage preferentially at supratentorial compartment. Subcortical gray and white matter necrosis and substitution by cystic cavities separated from one another by glial septations are the rule. The insult frequently occurs at perinatal period. Cranial follow-up ultrasound demonstrates a high reliability in the detection of MEM, demonstrating, better than CT, the edema and the cystic cavities and septations. MR imaging is a valuable complementary tool on appropriate extension and prognostic neurologic outcome definition, but its major drawback is mobilization and anesthesia requirements to perform it.

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KEY WORDS: Multicystic encephalomalacia, ultrasound, destructive brain disease

Scientific Exhibit 82

Doctor! What Is This “Thing” in My Nose? Imaging Characteristics of Nasal Masses

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PURPOSE

The purpose of this exhibit is to review the normal anatomy of the nasal cavity and the salient imaging characteristics of lesions encountered in this region. This will enable the radiologist to localize a lesion and provide a reasonable differential diagnosis based on location and imaging characteristics. Objectives: 1. Learn the normal nasal anatomy; 2. Learn the imaging characteristics of common intranasal masses; 3. Review the patterns of disease spread associated with nasal lesions.

MATERIALS & METHODS

We reviewed 106 cases of intranasal lesions from three major medical institutions.

RESULTS

The lesions encountered were congenital (5), squamous cell carcinoma (12), minor salivary gland tumors (6), neural tumors (8), inverting papillomas (14), sarcomas (3), lymphoma (10), metastatic disease (5), osseous lesions (8), vascular lesions (10), granulomatous disease (5), nongranulomatous inflammatory processes (15), and miscellaneous lesions (5). These lesions were analyzed with respect to location, effect on adjacent osseous structures, CT and MR appearance and pattern of disease spread.

CONCLUSION

Intranasal masses may originate in the nasal cavity or adjacent structures. Imaging plays an important role in the identification and assessment of tumor extent. Knowledge of the anatomy and imaging characteristics of lesions in this location is crucial.

KEY WORDS: Nasal masses, imaging characteristics

Scientific Exhibit 83

Imaging Features of Labyrinthitis Ossificans and Importance of MR Imaging in Its Management Planning

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PURPOSE

Labyrinthitis ossificans consists of abnormal bone formation that fills the normally patent cochlear and vestibular lumen as an end-stage sequel to various pathologies affecting the membranous labyrinth. Bacterial infections resulting in suppurative labyrinthitis are the most common cause for ossifi-

cation but this also can occur following viral infections, trauma and in otosclerosis. Clinical presentation is with sensorineural hearing loss. CT has been the most widely used imaging test in detection of this disease but it can underestimate the extent of involvement of cochlea and vestibular system.

MATERIALS & METHODS

MR imaging can help detect the disease missed on CT and can better show the entire extent of abnormality. This information may be helpful in the management. In patients with moderate to severe ossification of cochlea, drilling via facial recess approach may become necessary during cochlear implantation. If the implantation via conventional approach is unsuccessful, a circumodiolar trough for the electrode may be created via an extended transtympanic approach.

RESULTS

The importance of MR imaging in the diagnosis and treatment planning of this entity has not been addressed sufficiently in the literature. At our institution, MR imaging is often used as a complementary test or as a problem-solving tool in the presence of discrepant CT and clinical findings.

CONCLUSION

We collected and reviewed several cases of labyrinthitis ossificans from the teaching files in our department. Using this exhibit, we will present the imaging features of labyrinthitis ossificans and highlight the importance of MR imaging in the imaging evaluation of this entity.

KEY WORDS: Labyrinthitis ossificans, MR imaging, management

Scientific Exhibit 84

Aplasia or Hypoplasia of the Vestibulocochlear Nerve

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PURPOSE

Cochlear implantation has become an accepted treatment for severe to profound deafness and can be applied to patients with congenital sensorineural hearing loss.

MATERIALS & METHODS

Because the absolute requirements for cochlear implantation are the presence of a cochlea and of a cochlear nerve, imaging plays an important part in the work-up of cochlear implant candidates. For evaluating these structures, high-resolution (sub-millimeter) heavily T2-weighted MR imaging provides excellent information. Embryologic development of the vestibulocochlear nerve, inner ear (labyrinthine) and internal auditory canal (IAC) is complex. Anomalies of the inner ear and IAC (atresia, stenosis, or duplication) are associated often but not always with aplasia or hypoplasia of the vestibulocochlear nerve.

RESULTS

Though it can be difficult to distinguish the facial nerve and the three branches of the vestibulocochlear nerve inside the stenotic IAC, facial and vestibulocochlear nerves always can be evaluated in the cerebellopontine angle cistern. Aplasia or hypoplasia of the vestibulocochlear nerves can be found without any other anomalies. In this case, only the cochlear nerve usually is involved. In some patients, the canal between the fundus of ICA and the modiolus is stenotic. In this exhibit, we present imaging findings of several types of aplasia or hypoplasia of the vestibulocochlear nerve.

CONCLUSION

Radiologists will assume an expanding role in evaluating candidates of cochlear implantation and must be familiar with imaging findings that contraindicate implantation.

KEY WORDS: Cochlear nerve, inner ear anomaly, internal auditory canal

Interventional 85-94

Scientific Exhibit 85

Endovascular Treatment of Cerebral Aneurysms: Atypical Scenarios and Management Strategies

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PURPOSE

Endovascular management of cerebral aneurysms, both ruptured or unruptured, is becoming increasingly the first line option. Although there has been significant progress in recent years in the technical aspects of aneurysm treatment (1-3), some situations create unusual challenges, due to various factors, including aneurysm geometry, clinical presentation, or management plan.

MATERIALS & METHODS

We reviewed retrospectively the last 100 aneurysms treated by endovascular means in our institution. Twelve aneurysms in 12 patients, (12%) all but one involving the posterior circulation (3 vertebrobasilar fenestration-associated aneurysms, 3 vertebrobasilar dissecting aneurysms, 2 distal lateral basilar apex region, 1 broad-based basilar apex, 1 multilobed basilar apex, 1 distal PICA and 1 posterior communicating artery) were identified as atypical with regard to aneurysm configuration, clinical features, or management strategy. Six aneurysms had ruptured, and six were unruptured.

RESULTS

Out of these 12 patients, 2 died, and 10 had good to excellent outcomes. The two deaths were from unusual mechanisms, one attributed to reticular activating system infarction

without CT demonstrable stroke nor brainstem evoked potentials alteration, and the other to venous hemorrhage in the fourth ventricle causing a combination of mass effect and hydrocephalus. In fenestration-associated aneurysms, proper identification of the aneurysm limb is required for adequate aneurysm obliteration, and sparing of normal surrounding arterial branches (4). Dissecting aneurysms involve a circumferential arterial tear which repair involves either stent-assisted reconstruction or parent vessel occlusion. Distal broad-based basilar aneurysm, whether lateral wall or apical pose specific challenges (perforator ischemia, mass effect, hydrocephalus) due to the compact nature and the importance of surrounding anatomical structures. Distal convexity artery aneurysms may require parent vessel occlusion and subsequent physiologic hemodynamic manipulation. Lastly, some aneurysms may require treatment not for fear of hemorrhage, but for stroke prevention from intraaneurysmal thrombus migration.

CONCLUSION

There continues to be significant advances in endovascular aneurysm therapy. However some situations, whether due to unusual anatomical configurations, clinical presentations, or management challenges, require planning that does not rely solely on technical solutions.

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KEY WORDS: Aneurysm, endovascular therapy, unusual

Scientific Exhibit 86 (eSE)

Endovascular Treatment of Dural Cavernous Sinus Fistulas Using Transvenous Occlusion in Forty-Five Patients

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PURPOSE

Endovascular therapy, using transarterial or transvenous approaches, has evolved as the most important treatment modality for patients with dural cavernous sinus fistulas (DCSFs). For endovenous catheterization of the cavernous

Scientific Exhibit 87

Spinal Arteriography: A Pictorial Review

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PURPOSE

The purpose of this exhibit is to present a detailed review of spinal cord and column vascular anatomy and discuss the angiographic differential diagnosis of common vascular and neoplastic lesions that affect the spinal cord and column.

MATERIALS & METHODS

A retrospective review of 25 cases was performed over the last 5 years of experiences at the section of neuroradiology at University of Virginia medical center. All these patients had undergone selective catheter angiographic evaluation for work-up of neoplastic or vascular pathology including spinal arteriovenous malformations, spinal dural arteriovenous malformations, metastatic lesions, schwannoma, meningioma, Cobb's syndrome (metameric disease), vertebral artery to epidural vein fistula and V-V fistula. A case-based discussion of the basic anatomy, angioarchitecture, and the differential diagnosis of these cases is included. Where appropriate cross-sectional images are used to highlight the angiographic findings. The issues relevant to endovascular therapy will be discussed also.

RESULTS

Out of the 25 cases reviewed, 7 were neoplastic lesions, 8 dural avms, 2 perimedullary avms, 1 cobb syndrome, 1 vertebral artery to epidural vein fistula, 2 V-V fistulas. Three were negative and in one case the final diagnosis could not be established.

CONCLUSION

While cross-sectional imaging does have a role to play in the diagnosis of spinal vascular lesions selective catheter angiography remains the gold standard for diagnosis of spinal vascular lesions. Recognition of the dural, intradural, and radiculomedullary vessels is of paramount importance; particularly for those requiring endovascular management which is only possible with a selective catheter study. Tumor lesions and dural AVMs constituted the bulk of cases referred for spinal angiography at our institution.

KEY WORDS: Angiography, spinal, arteriovenous malformation

sinus various anatomical routes exist of which the most important are: the inferior petrosal sinus (IPS), the superior petrosal sinus (SPS), and the superior ophthalmic vein (SOV). We report on anatomical results and clinical outcome of 45 patients treated by transvenous embolization using various routes to the cavernous sinus.

MATERIALS & METHODS

Forty-five patients (32-90 years, f/m: 32/13) presented symptoms typical for DCSFs such as eye redness, exophthalmus, chemosis, diplopia or retroorbital pain. There was no intracranial hemorrhage and no focal neurologic deficit. Fistula types included type D (41), type B (3), and Type C (1). In 8 patients a bilateral fistula and in 9 patients a cortical venous drainage was found. For transvenous catheterization of the cavernous sinus, various approaches were used including the IPS (37), the SOV (13), the SPS (4) the frontal vein (1) and the Sylvian vein (1). Catheter navigation to the fistula site was performed from a contralateral approach in 8 patients and using a direct puncture of the internal jugular vein in 3 patients. For occlusion of the AV shunt in all but one patient platinum detachable coils were used and combined in few cases with additional fibered coils (n = 7) or liquid adhesives (n = 3). One patient was treated with transvenous injection of NBCA only.

RESULTS

Anatomical cure, confirmed by angiography, was obtained in 42/45 patients (FU in 3 patients pending), in a single session in 35 patients and as an initial result in 28 patients. In 41 patients complete clinical recovery was observed (FU in 4 patients pending). There was no permanent major or minor deficit. One patient developed a transient sixth nerve palsy (2.2%), in another patient a venous rupture remained clinically silent.

CONCLUSION

Biplane angiographic systems and currently available endovascular tools and devices have significantly improved the technical success rate of TVO. This has lead to an increasing rate of anatomical and clinical cure of patients with DCSF while lowering the complication rate at the same time, and establishes TVO as the treatment method of choice. The consistent use of all possible anatomical routes to the CS allows for treatment of almost all patients with DCSFs, and "intractable fistulas" have become the exception.

KEY WORDS: Dural cavernous sinus fistula, transvenous occlusion

Scientific Exhibit 88 (eSE)**Preliminary Experience on the Use of a New Generation of Intracranial Stents (Neuroform) for Cerebral Aneurysms**

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PURPOSE

To review our experience on the use of Neuroform stents in the treatment of intracranial aneurysms, to identify pitfalls, and avoid complications.

MATERIALS & METHODS

A retrospective review of all patients previously treated with Neuroform stents was performed. Clinical and angiographic follow-up was performed.

RESULTS

Thirteen stents were placed in 13 patients with 17 attempts (11 female patients, average age of 49 years). Four stents were not deployed due to device failure. Five patients presented with subarachnoid hemorrhage, 3 patients had headaches, and the remainder were asymptomatic. Fifteen aneurysms were treated with aneurysm locations: 4 paraophthalmic; 3 posterior communicating; 1 superior hypophyseal; 1 vertebro-basilar junction; 1 dissecting vertebral artery; 1 posterior ICA wall, and 4 para/supraclinoid (one patient had 3 aneurysms). Eleven patients had excellent results, one patient suffered an ICH while on heparin, aspirin and GP IIa/IIb inhibitors due to development of nonocclusive thrombus on the stent, and one suffered a TIA within 24 hours of stent placement (PTT < 30 seconds). Angiographic follow-up in four patients showed excellent results.

CONCLUSION

Intracranial stenting is a feasible option of wide-necked aneurysm treatment. Technical knowledge on stent characteristics and deployment are essential before use. The first 24 hours postdeployment is the most critical for complications. Long-term follow-up is warranted for evaluation of this new device.

KEY WORDS: Aneurysms, Neuroform, intracranial stent

The authors of this work have indicated the following affiliations/disclosures: Boston Scientific Co.: Consultant.

Scientific Exhibit 89**Pudendal Nerve Blocks**

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PURPOSE

Pudendal neuralgia is difficult to diagnose and therefore often misdiagnosed. It is a debilitating disorder with severe burning pain in the perineum, vagina, vulva, penis and scrotum. The differential diagnoses include vulvodynia, tumors, spine disease, dermatologic conditions, prostatitis, vestibulitis, chronic vaginitides and psychosomatic disorders. Nerve blocks are often diagnostic and are sometimes therapeutic. The purpose of this exhibit is to demonstrate the technique and discuss the benefits of pudendal nerve blocks.

MATERIALS & METHODS

The pudendal nerve arises from the sacral plexus (S2-S4) and courses through the pelvis around the ischial spine between the sacral spinous and sacral tuberos ligaments. It splits up into the anal, perineal, and clitoral/penile branches. It turns anteriorly through the lower sciatic foramen underneath the surface of the levator muscle into Alcock's canal where the nerve flattens out between the double fascia.

RESULTS

Pudendal nerve block is done under CT guidance using 22-gauge spinal needle placed next to the ischial spine or into the Alcock's canal where long-acting local anesthetic is injected. The procedure can be repeated with a placebo to confirm the source of the symptoms. If the block is positive, steroid injection, botulinum toxin injections or surgical release of the nerve may result in permanent relief.

CONCLUSION

Pudendal nerve blocks are performed readily on an outpatient basis with low risk of complications. The results are very helpful in confirming the diagnosis and if not therapeutic, steroid or botulinum toxin injections, or surgical release, may yield longer term relief.

KEY WORDS: Pudendal nerve

Scientific Exhibit 90 (eSE)**Thermo Reversible Liquid Embolic Agent for the Treatment of Vascular Disease**

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PURPOSE

We developed a new embolic agent, thermo-reversible gelation polymer (TGP). This polymer owns unique characteristics that can be solidified by body temperature. We evaluated angiographic and histopathologic findings of this new liquid embolic agent.

MATERIALS & METHODS

Thermo-reversible gelation polymer has a sol-gel transition temperature (TT). It becomes a liquid state at a temperature lower than the sol-gel transition temperature and becomes gel state above TT. It can also slowly deliver biologically active substance such as growth factor or chemotherapy drugs. The polymer was mixed with radiopaque material without solvent. Two different TGPs were evaluated. Type A solidifies at 15°C and Type B solidifies at 20°C. Because both TGPs have lower TT than body temperature, they solidify in the body lumen. Ten renal arteries of seven swine were embolized with TGPs (Type A: n = 5, Type B: n = 5). Angiographic follow-up was performed at day 14. Subsequently, animals were sacrificed. Histopathologic evaluation was performed.

RESULTS

All renal arteries were embolized successfully with TGP. The polymer was delivered like GDC coil in the vascular lumen. Type A required stronger injection pressure than Type B due to high viscosity. Angiographic follow-up was performed 2 weeks after embolization. Although some degree of recanalization was observed, histopathologic findings demonstrated tissue necrosis of the embolized area.

CONCLUSION

This new thermo-reversible liquid embolic agent can be used effectively for embolization of kidney arteries in swine. Further modifications such as mechanical stability would be mandatory prior to clinical application.

KEY WORDS: new liquid embolic agent

Scientific Exhibit 91

Balloon Test Occlusion with Perfusion CT Imaging Utilizing Intraarterial Contrast Injection

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PURPOSE

Therapeutic occlusion of the unilateral internal carotid artery (ICA) is sometimes inevitable in the treatment of large or giant cerebral aneurysms or skull base tumors. Balloon test occlusion (BTO) is performed to evaluate the collateral flow when a permanent ICA occlusion is planned. BTO with neurologic evaluation alone, however, has a rather high false-negative rate. In order to improve the sensitivity, several modalities such as xenon-enhanced computed tomography (CT), single photon emission CT (SPECT) or positron emission tomography (PET) have been combined with BTO. Perfusion CT (PCT) is another emerging modality that is used mainly for the diagnosis of acute stroke. Our institution has an angio suite equipped with a multidetector CT. It enables us to perform BTO and PCT without transferring the patient. We performed a preliminary study to evaluate the efficacy and the safety of the BTO combined with PCT within one procedure.

MATERIALS & METHODS

From July 2003 to December 2003, five patients (all female) underwent BTO with PCT in our institution. Four of them had wide-necked or giant aneurysms. The fifth one previously had undergone aneurysm surgery that ended in proximal occlusion. She had another aneurysm on the contralateral side and PCT was performed to evaluate the vascular reserve. All of the procedures were performed in the angio/CT combination suite (Miyabi; Siemens, Erlangen, Germany). Bilateral femoral arteries were punctured and femoral sheaths were placed. BTO was performed in the usual fashion, inflating the balloon in the cervical ICA for 30 minutes with neurologic examination every 5 minutes. When the patient passed the 30-minute BTO clinically, PCT was performed subsequently. The balloon was kept inflated, and contrast material was injected from a pigtail catheter, the tip of which was placed in the ascending aorta. The data obtained were transferred to a workstation and perfusion maps of CBF, cerebral blood volume (CBV), and time to peak (TTP) were generated using software (Perfusion CT software; Siemens).

RESULTS

Although all of the patients had passed the BTO clinically, the CBF and the CBV maps of two patients revealed significant decrease in the occluded hemisphere. One of these two patients underwent a SPECT study during BTO that also showed reduced CBF in the occluded hemisphere. The first three patients were scanned for 40s after injecting 30 ml contrast material at a rate of 8 ml/s. As we found that less contrast was sufficient to obtain a sharp arterial input function, we injected only 10 ml at 5 ml/s for the last two patients and reduced the scan time to 30 seconds. There was no procedure-related morbidity.

CONCLUSION

PCT using intraarterial contrast injection during BTO was performed successfully and safely. Intraarterial injection allowed us to obtain excellent time-attenuation curves by utilizing less contrast material and less radiation. This technique seems promising; however, further studies are necessary as the number of patients was limited and quantitative results should be validated against those of other modalities.

KEY WORDS: Perfusion, balloon occlusion, CT

The authors of this work have indicated the following affiliations/disclosures: Siemens Medical Solutions: Senior scientist.

Scientific Exhibit 92 (eSE)

Indication for Endovascular Improvement of Lateral Sinus Circulation in Case of Idiopathic Intracranial Hypertension

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PURPOSE

The significance of perturbed venous efflux for generation of intracranial hypertension in many pathologic conditions [e.g., arteriovenous malformation (AVM), dural arteriovenous angioma, dural sinus thrombosis] has been recognized already. In cases of idiopathic intracranial hypertension or pseudotumor cerebri the venous hypertension has been suggested also to have a pathogenetic influence, but the etiology of pathophysiologic mechanism in such conditions remains unknown. The goal of this study is to document the clinical response to an endovascular improvement of lateral sinus circulation in cases with refractory idiopathic intracranial hypertension without apparent sinus obstruction.

MATERIALS & METHODS

Three obese women and one man (16, 18, 25, and 26 years old) were referred with history of progressive headache and visual disturbance and of initial change of personality. They underwent MR imaging, conventional cerebral angiographies with cerebral venography, and manometry of dural sinuses. Percutaneous angioplasty of dural sinuses with compliant balloons were obtained in two cases.

RESULTS

MR images were normal in all four patients. Lumbar cerebrospinal fluid pressure had been elevated in all patients between 30 cm H₂O. MR venography demonstrated normal dural venous sinuses. The conventional cerebral venous phase showed questionable irregularities of lateral sinuses in all patients. The direct transfemoral dural sinus venography revealed decent stenotic lesions in the junction of transverse sinus to the sigmoid sinus in identical fashion of all patients. The manometry of dural sinuses revealed pressure gradients by 50 mm Hg in the first patient (torcula pressure 66 mm Hg, jugular pressure 16 mm Hg), by 20 mm Hg in the second patient (torcula pressure 36 mm Hg, jugular pressure 16 mm Hg), by 4 mm Hg in the third patient (torcula pressure 20 mm Hg, jugular pressure 16 mm Hg), and by 4 mm Hg in the fourth patient (torcula pressure 16 mm Hg, jugular pressure 12 mm Hg). Angioplasty of lateral dural sinuses had been performed in both the first and second cases. The venographies showed only decent regression of stenotic lesions; but the clinical course in both patients, a few days later, underwent a dramatic improvement with resolution of papilledema and headache. The third and fourth patients underwent medical therapy only.

CONCLUSION

We were able to document a dramatic improvement in symptoms in two cases with idiopathic intracranial hypertension with a consequent reduction of pressure gradients across the lateral sinuses after angioplasty of dural sinuses. Obviously, the latent elevated pressure gradients across the lateral sinus even in cases with only distinct stenotic sinus lesions can

produce an idiopathic intracranial hypertension or pseudotumor cerebri, especially in obese women. In both cases, with medical treatment only and clinical presentation of an idiopathic intracranial hypertension, a central venous pressure elevation had been found across the lateral sinuses without any relevant pressure gradients. This indicates that in particular cases of idiopathic intracranial hypertension a distinct venous outflow obstruction might have a causal relation and consequently might promote the clinical progress of this disease.

KEY WORDS: Idiopathic intracranial hypertension, dural sinus angioplasty

Scientific Exhibit 93

Pitfalls in Gamma Knife Treatment of Tic Doloareaux on Stereotactic 3D MR Imaging: Morphologic Changes Affecting Targeting

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PURPOSE

The treatment of tic doloareaux has evolved from the more morbid chemical, thermal, and electrical rhizotomies of the trigeminal nerve to the more precise gamma knife radiosurgery. Identifying the nerve root at the pons on stereotactic MR imaging to select the treatment focus was not so simple a chore because of encountered morphologic changes. This exhibit will present our experience in targeting 131 patients for tic doloareaux by gamma knife, emphasizing how these morphologic changes could affect targeting, and whether they played a role in treatment failure.

MATERIALS & METHODS

All patients were imaged on a 1.5 T MR imager with routine sets of images as well as 1 mm reformatted T1-weighted MP-RAGE in all three planes with a Leksell head frame reviewed on Siemen's PACS and Leksell imaging workstations. A focus was selected along the visualized course of the nerve precisely in the center of it on the axial one mm MP-RAGE images so the 50% isodose line did not or just barely touched the pons, and its location confirmed in the other two planes. Cine function was applied to the MP-RAGE images to reduce partial volume averages of tortuous nerves to select the thickest portion of the nerve to measure for asymmetries in size to the contralateral nerve.

RESULTS

The affected nerve (92 right/49 left) was most commonly smaller than the opposite nerve (44% equally right and left) ranging from 1-2 mm difference in measured axial diameter to one so shrunk that it was difficult to visualize even on all three planes. It was also the most common finding in 42 patients requiring a second treatment (20 right/22 left). The next most common finding was a normal nerve without asymmetry in size (23%). Vascular compression by an ectatic basilar artery was also seen (21%) with visible compression of the nerve which was also smaller, as was abnormal

thickening of the nerve (12%) all equally right and left. Failure rate was higher with left (45%) compared to right (21%).

CONCLUSION

Difficulty in outlining the nerve due to atrophy or a nerve that is flattened against the pons, presents a targeting challenge. In such situations we triangulate the more distal course of the nerve from Meckel's cave, along a line directed posterior and perpendicular to the cave. Atrophy may reflect chronicity with nerve shrinkage. The fact that an atrophic nerve was the most common finding suggests that treatment failure may be related to poor definition of the target. Basilar artery compression deflects and compresses the nerve making it difficult to target, and often is associated with nerve atrophy. This finding of vascular compression was also the next most common morphologic change encountered in the group requiring a second treatment. Nerve thickening probably represents local scar or arachnoid thickening. Recognition of these problems may still be of no help since the limiting factor is good anatomical definition. Careful targeting of the nerve in all three planes using cine function should reduce treatment failures.

KEY WORDS: Tic doloureux, gamma knife surgery, radiosurgical trigeminal rhizotomies

Scientific Exhibit 94

Angioplasty and Stenting of Vascular Diseases of the Head and Neck Region: A Technical Approach

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PURPOSE

Angioplasty and stenting has been applied widely in atherosclerotic carotid stenosis for many years. The technical successful rate is more than 98% to 99%. However, the causes of technical difficulty and the application of stenting in nonatherosclerotic vascular diseases were not discussed widely. There are two purposes of this technical exhibition: (1) To review the technical difficulty and the ways of resolution of atherosclerotic disease of the head and neck region, (2) To extend the technical application of angioplasty and stenting in nonatherosclerotic vascular diseases of the head and neck region.

MATERIALS & METHODS

During the past 6 years, there were 260 cases of vascular lesions of the head and neck region who accepted angioplasty and stenting in our hospital. The vascular disorders were classified into three categories: atherosclerotic arterial disease, nonatherosclerotic arterial disease, and venous sinus disorders. The technical considerations for angioplasty and stenting of atherosclerotic arterial disease include the very tortuous aortic arch, a predilatation test for very high-grade carotid stenosis (> 99%), ulcerated carotid plaques, large eccentric carotid plaques, very tortuous carotid artery and subclavian artery, and intracranial carotid stenosis. The technical consideration for angioplasty and stenting of nonather-

osclerotic arterial diseases include radiation-induced carotid and subclavian artery stenosis, dissection of carotid and vertebral artery, fibromuscular dysplasia of carotid artery, intracranial carotid aneurysm, carotid pseudoaneurysm, and foreign body of carotid artery. In venous sinus disorders, we showed a double-wire method for stenting of transverse sinus stenosis, and combined angioplasty and thrombolytic therapy for venous sinus thrombosis.

RESULTS

The technical success rate of atherosclerotic carotid stenosis was about 98.9%. The embolic complication of carotid angioplasty and stenting is about 4.8%. No embolic complication was noted in the nonatherosclerotic arterial diseases of the head and neck region. Some technical complications were noted in this study. They included vascular dissection, extravasation during the manipulation, and dislodgement of the stent.

CONCLUSION

Angioplasty and stenting is an effective management with high technically successful rate for the vascular disorders of the head and neck region. The embolic complication rate of atherosclerotic carotid stenosis obviously can be reduced by protection devices. The nonembolic complications, commonly seen in the newcomers of this field, need to be avoided by meticulous practice and careful treatment planning.

KEY WORDS: Stenting, vessels, head and neck

Pediatrics
95-107

Scientific Exhibit 95

Transcranial Doppler in Children: Applications in Nonsickle Cell Patients

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PURPOSE

The purpose of this scientific exhibit is to review the key imaging findings of various clinical conditions in which transcranial Doppler (TCD) may be applied other than sickle cell disease.

MATERIALS & METHODS

In children with sickle cell disease, TCD has become widely accepted as the modality of choice for screening cerebrovascular disease due to the fact that it is noninvasive, requires no radiation, is portable, repeatable, and provides velocity measurements of major intracranial vessels that otherwise may be unavailable.

RESULTS

Because of these attributes, in recent years TCD has been applied to a growing list of pathologic processes that involve the major intracranial vessels.

CONCLUSION

Specific topics of discussion will include distinguishing subdural vs subarachnoid spaces, hydrocephalus, vasculitis, hypoxic/anoxic brain injury, and brain death. Potential pitfalls in the interpretation of TCD will be discussed also.

KEY WORDS: Pediatric, transcranial, Doppler

Scientific Exhibit 96

MR Imaging of the Fetus In Utero I: A Practical Guide to Systematic Analysis of the Central Nervous System

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PURPOSE

Well established protocols exist for the sonographic examination of the fetus, encompassing differing levels of detail depending on the overall risk of the individual pregnancy (i.e., from a routine screening examination up to a tertiary-level detailed assessment of a high-risk pregnancy). No such protocols are established yet for fetal MR imaging. In our institution we have attempted to establish a protocol for reporting fetal MR examinations, in order that a systematic and methodical approach is adopted by our radiologists, including those who are not used to reading these examinations, and to avoid missing important anatomical abnormalities.

MATERIALS & METHODS

Retrospective analysis was performed in over 130 consecutive fetal MR examinations performed for CNS and non-CNS indications.

RESULTS

Analysis included, but was not limited to, biometry, including biparietal diameter, transcerebellar diameter, ventricular atrial width, craniocaudal diameter of the cerebellar vermis, the presence of the cavum septum pellucidum and corpus callosum and other midline and lateral structures, cortical development and appearance of sulci and major fissures.

CONCLUSION

We would like to demonstrate a practical guide to analysis of the central nervous system of the fetus *in utero*, including how to perform the biometric measurements, and examples of normal and abnormal biometry and development. (Part 1 of 2. See abstract 851 for part 2.)

KEY WORDS: Fetal MR imaging, development

Scientific Exhibit 97

MR Imaging of the Fetus In Utero II: and the Rest (non-CNS)

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PURPOSE

Well established protocols exist for the sonographic examination of the fetus, encompassing differing levels of detail depending on the overall risk of the individual pregnancy (i.e., from a routine screening examination up to a tertiary-level detailed assessment of a high-risk pregnancy). No such protocols are yet established for fetal MR imaging. In our institution we have attempted to establish a protocol for reporting fetal MR examinations, in order that a systematic and methodical approach is adopted by our radiologists, including those who are not used to reading these examinations, and to avoid missing important anatomical abnormalities. Additionally, most of our examinations are performed for CNS indications, with which most neuroradiologists should feel comfortable. However they invariably also include non-CNS anatomy with which neuroradiologists might feel less comfortable, but which should be reviewed routinely also, and not simply glossed over or even worse ignored.

MATERIALS & METHODS

Retrospective analysis of was performed in over 130 consecutive fetal MR examinations performed for CNS and non-CNS indications.

RESULTS

Analysis included, but was not limited to, evaluation of thoracic and abdominal situs, lung parenchyma, diaphragms, liver and gallbladder, stomach, kidneys (including biometry), bladder, cord insertion, cord vessels, placental site and morphology, and amniotic fluid volume.

CONCLUSION

We would like to demonstrate a practical guide for neuroradiologists for the analysis of the rest of the fetus (non-CNS), including how to perform the biometric measurements, and examples of normal and abnormal development.

Part 2 of 2. See abstract 750 for part 1.

KEY WORDS: Fetal MR imaging, development

Scientific Exhibit 98

Holoprosencephaly: A Review of Cranial Cleavage and Diverticulation Disorders

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PURPOSE

To examine the spectrum of congenital cranial diverticulation disorders, including clinical manifestations and radiographic presentation using CT, MR imaging, and ultrasonography.

MATERIALS & METHODS

A pictorial review of holoprosencephaly including the alobar, lobar, and semilobar subtypes, a discussion of septo-optic dysplasia, and a review of embryologic processes of cranial cleavage and diverticulation is presented. Cross-sectional images were obtained on high-speed multidetector CT scanners and 1.5 T MR scanners at a level I trauma center and a children's hospital specializing in neonatology.

RESULTS

The classification of this disorder is demonstrated with characteristic imaging findings on CT, MR imaging, and ultrasound. Associated clinical disorders including midline facial defects, neuronal migrational disorders, trisomies, and extracranial manifestations are illustrated.

CONCLUSION

A pictorial essay of the various subtypes of holoprosencephaly and a discussion on classification based on characteristic MR imaging, CT, and sonographic findings provide an overview of this important category of congenital cranial malformations.

KEY WORDS: Holoprosencephaly, congenital malformations, diverticulation disorders

Scientific Exhibit 99

Isolated Hypothalamic Fusion: Holoprosencephaly?

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PURPOSE

The holoprosencephalies are a group of phenotypically variable genetic forebrain malformations defined by failure of normal differentiation and cleavage of the prosencephalon. The three classic subcategories of alobar, semilobar, and lobar holoprosencephaly are well known. A holoprosencephalic variant of middle interhemispheric fusion has been described recently. We have identified three cases of a very subtle form of midline fusion involving only the hypothalamus. The purpose of this exhibit is to present our series of

isolated hypothalamic fusion along with a pictorial review of the embryogenesis and imaging characteristics of holoprosencephaly.

MATERIALS & METHODS

The MR examinations and clinical findings of children with holoprosencephaly or midline facial malformations since 2000 were reviewed.

RESULTS

Three cases of isolated hypothalamic fusion were identified. One case was accompanied by an ectopic neurohypophysis. All three cases demonstrated varying degrees of developmental delay, seizures, and/or midline craniofacial abnormalities.

CONCLUSION

Our three cases of isolated fusion of the hypothalamus, a structure believed to belong to the diencephalon, underscores the heterogeneity of the "holoprosencephalies." This form of midline fusion is subtle but important to recognize because of the clinical implications it carries.

KEY WORDS: Holoprosencephaly, diencephalic fusion, hypothalamus

Scientific Exhibit 100 (eSE)

Congenital Malformations of the Ear in Pediatric Patients: CT and MR Imaging Evaluation

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PURPOSE

To analyze features of the congenital deformities of the ear through CT and MR imaging and to evaluate the normal and pathologic range diameters of inner ear structures in neurosensory hearing loss. The congenital malformation of the ear includes abnormalities of the bony structure (20%) and of the membranous labyrinth (80%). Abnormalities of the inner ear typically give rise to sensorineural hearing loss or vestibular symptoms. Such abnormalities usually are best evaluated with dedicated high resolution MR imaging, using high resolution CT as an adjunct to define associated bony abnormalities. MR imaging is a useful adjunct in evaluating central involvement in congenital neurosensory loss.

MATERIALS & METHODS

Seventy-one children (including 31 males and 30 females; age range 1-18 years) affected with moderate to severe sensorineural hearing loss underwent CT and/or MR scan. Twenty-seven patients were scanned with CT only, while 44 underwent both techniques on the same day. Not collaborating children (38 children under 6 years) were sedated with laryngeal mask. Among the 71 patients, 17 resulted having a defined genetic disorder. We have analyzed 22 normal ears belonging to children affected with monolateral flogistic phenomenon. Axial CT scans were performed from the superior orbitomeatal line to the top of petrous bone. Coronal CT scans were performed parallel to the posterior wall of maxillary sinus, from posterior margin of temporomandibular

joint to the posterior and lateral side of petrous bone. 1 mm thickness acquisitions were obtained for each plan. MR studies have been carried out using 3D axial FSE T2-weighted (TE 119 ms, TR 5000 ms, FOV 190 mm, Flip angle 90°, NSA 1, thk 0.8 mm, matrix 256 x 256) and oblique coronal (perpendicular to VIII cranial nerve) T2-weighted sequences at a 1.5 T scanner (Marconi-Philips).

RESULTS

Twenty-seven patients with abnormalities were found. The following abnormalities were detected: coclear abnormalities (12 cases); internal auditory canal abnormalities (5 cases); auditory ossicle abnormalities (8 cases); external auditory deformities (7 cases); dilatation of vestibular aqueduct (14 cases); VIII nerve hypoplasia (8 cases). In 9 cases the abnormalities were unilateral while in 18 cases they were bilateral.

CONCLUSION

CT and MR imaging demonstrate accurately pattern, extent, and associated changes of congenital deformities of the ear. The pathologic features are better defined when the techniques are combined since MR imaging can analyze only the coclear component of the VIII nerve. An early characterization of the ear abnormalities and their precise analysis made through CT and MR imaging are necessary to give an indication for the eventual audiological treatment. Measurements of cochlear, vestibular, and IAC structures, compared to the normal values, may reveal subtle abnormalities otherwise misdiagnosed. MR imaging always should be performed when associated encephalic malformations are suspected.

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KEY WORDS: Petrous bone malformation, inner ear imaging, petrous bone CT

Scientific Exhibit 101 (eSE)

Imaging Spectrum of Tuberous Sclerosis

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PURPOSE

To demonstrate the imaging finding of patient with tuberous sclerosis.

MATERIALS & METHODS

Eleven cases of tuberous sclerosis were included. The imaging study included T1-weighted image, FLAIR image, contrast-enhanced T1-weighted image, MR spectroscopy

(MRS), diffusion tensor image (DTI), and fractional anisotropy (FA). The first three pulse sequences were focused on the tubers in subependymal region, cortical region, and white matter. The last three were focused in the white matter next to a certain cortical tuber.

RESULTS

In the subependymal tubers, the T1-weighted images revealed low signal intensity (SI) in 1 case, intermediate SI in 6 cases, high SI in 4 cases. On FLAIR images, low SI with high SI rim was shown in 6 cases, intermediate SI in 3 cases, and high SI in 2 cases. Only 4 cases had abnormal contrast enhancement in the subependymal tubers. In the cortical tubers, the T1-weighted images revealed isointense on 11 cases with focal thickening. On FLAIR images, 9 cases had hyperintense and 2 cases had intermediate intensity. No case had abnormal enhancement after contrast administration. In white matter tubers, T1-weighted images revealed blurred gray-white matter junction in 10 cases, and all cases were in low SI. On the FLAIR, all of them became bright SI, and only 2 cases had abnormal enhancement. All the cases had abnormal DTI in the region next to the cortical tubers but only 9 cases revealed abnormal FA. On MRS study, there was no significant difference between the white matter next to the tubers and the one in contralateral control side.

CONCLUSION

The imaging finding in the tuberous sclerosis is best shown by T1-weighted image, FLAIR and DTI. The images change in the cortical, subependymal, and white matter tubers are not exactly the same. Their underlying pathology should be considered.

KEY WORDS: Tuberous sclerosis, image, diffusion

Scientific Exhibit 102

Bilambdoid Craniosynostosis: A Case Presentation and Review of the Literature

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PURPOSE

To present the high spatial-resolution CT images of a case of bilambdoid craniosynostosis. To review the incidence and clinical presentation of this rare form of craniosynostosis. To discuss the current CT imaging techniques for craniosynostosis.

MATERIALS & METHODS

Thin-slice axial CT images with three-dimensional surface reconstructions of a child presenting to our institution with brachycephaly are presented. The radiologic and surgical literature is reviewed focusing on the incidence, clinical presentation, and imaging of nonsyndromic bilambdoid craniosynostosis.

RESULTS

Axial CT images and three-dimensional surface reconstructions of the skull of our patient demonstrate closure of both lambdoid sutures and the posterior portion of the sagittal

suture. Review of the literature yielded 47 cases of bilambdoid craniosynostosis confirmed by either CT imaging or pathologic evaluation of the resected cranial sutures. The majority of the children were neurologically normal and presented with brachycephaly. Complications most commonly included hydrocephalus and increased intracranial pressure. High spatial-resolution CT with three-dimensional rendering is superior to plain radiographs at diagnosing craniosynostosis and assisting surgical planning.

CONCLUSION

Bilambdoid craniosynostosis is a rare form of craniosynostosis presenting with brachycephaly, a high occiput, frontal bossing, and low-set ears. Our case illustrates the value of high spatial-resolution CT combined with three-dimensional rendering in the diagnosis of bilambdoid craniosynostosis.

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KEY WORDS: Craniosynostosis, lambdoid suture

Scientific Exhibit 103

Hypoxic-Ischemic Encephalopathy: A Prospective Comparison of "State-of-the-Art Ultrasound" and MR Imaging: Can Ultrasound Compete with MR Imaging?

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PURPOSE

To prospectively characterize the range of abnormalities found in hypoxic-ischemic encephalopathy (HIE) using high resolution ultrasound (HR US) and Doppler techniques and to compare these to MR findings.

MATERIALS & METHODS

Ultrasound was performed in 65 neonates (16 preterm and 49 term) within 2 hours of clinically indicated MR imaging. Informed consent and ethics approval were obtained. MR imaging included routine T1 and FSET2 sequences, as well as diffusion-weighted (DW) imaging and MR spectroscopy. The US studies were performed with state of the art US machines, optimizing images by using high-resolution transducers and Doppler techniques. Ultrasound was performed by three different pediatric radiology fellows or one US technologist, and reported with staff radiologists. The physicians and technologist were blinded to the MR findings. Ultrasound findings were compared and correlated with the MR images in consultation with two neuroradiologists. We used MR imaging as a gold standard and divided our cohort

into 3 main groups. Group I consisted of those neonates who had positive findings on DW images (31 neonates). Group II comprised those patients who had negative DW images, no lactate on MR spectroscopy and no suspicious findings for HIE on conventional MR sequences (17 neonates). Group III consisted of those patients who had equivocal findings for HIE on conventional sequences, negative DW images and no lactate on MR spectroscopy; these patients were excluded for statistical analysis.

RESULTS

Four specific features were evaluated on US. These included: peripheral and central gray scale HR US echogenicity, resistive indices, peak systolic and end diastolic velocity measurements, and the presence or absence of hyperemia. All 31 patients in group I, showed at least 1 US abnormality and 3 patients in group II showed abnormal peripheral findings. Our data demonstrate that while MR imaging reveals additional findings, HR US provides information that is more encouraging than previously suggested. We will demonstrate specific HR US features, such as dense sulci, juxta-cortical hyperechogenicity, hyperemia, and instability of resistive indices, that were particularly helpful in the evaluation of neonatal HIE related damage.

CONCLUSION

Our preliminary data show that US performed by paying meticulous attention to the US technique can show subtle abnormalities suggestive of HIE. In this way US may help triage infants for further imaging studies with MR imaging. They may be used also to follow the clinical status of infants who may be too unstable to transport to MR imaging or who may be supported with equipment (ECMO) which is not compatible with MR imaging.

KEY WORDS: Ultrasound, hypoxic ischemic encephalopathy

Scientific Exhibit 104 (eSE)

Neonatal Cranial Ultrasound: A Practical Review and Pictorial Essay

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PURPOSE

Despite the increasing utilization of CT and MR imaging, ultrasound remains the initial diagnostic examination for evaluation of the neonatal brain. The purpose of this exhibit is to review the technique of and indications for neonatal cranial ultrasound. Representative images from normal and abnormal examinations will be presented.

MATERIALS & METHODS

A normal examination emphasizing the requisite anatomy necessary for a complete ultrasound evaluation of the neonatal head will be provided. Representative images of normal and abnormal examinations from current clinical cases and teaching files were selected to demonstrate important points.

RESULTS

Two of the more common conditions visualized with neonatal cranial ultrasound are germinal matrix hemorrhage and periventricular leukomalacia. Representative examples of the four grades of germinal matrix hemorrhage will be provided; examples of periventricular leukomalacia also will be presented. In a tertiary hospital setting, less common abnormalities are frequently encountered. Examples of Vein of Galen malformation, congenital absence of the corpus callosum, mineralizing angiopathy, Dandy-Walker malformation, holoprosencephaly, coarctation of the lateral ventricles, venous sinus thrombosis, arachnoid cyst of the temporal lobe, intrauterine infection, temporal lobe hemorrhages, abscess and a resolving hematoma are shown. Correlative imaging with CT and MR is provided when available.

CONCLUSION

This exhibit presents a practical and concise review of neonatal cranial ultrasound, addressing exam technique and indications, normal anatomy and representative examples of both common and uncommon abnormalities encountered in the neonate.

KEY WORDS: Pediatric brain, neonatal cranial ultrasound

Scientific Exhibit 105**Hypoxic-Ischemic and Hypoglycemic Encephalopathy: Characteristic Patterns of Injury**

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PURPOSE

Diffuse cerebral hypoxia, ischemia and hypoglycemia lead to characteristic patterns of brain injury. This exhibit reviews the causes of such brain injury, the imaging findings, and the factors which determine the pattern of injury.

MATERIALS & METHODS

A retrospective review of cases from several affiliated institutions was performed and relevant scientific literature reviewed.

RESULTS

Neuronal and glial injury occur rapidly when the brain is deprived of oxygen and nutrients. The extent and patterns of injury are affected by the nature of nutrient deprivation (e.g., hypoxia, hypoglycemia, ischemia), the severity and duration of the insult, and the age-dependent regional susceptibility of neural tissue to this deprivation. Accordingly, there is substantial variability in the pattern of injury. However, in some clinical settings, the imaging picture is distinctive and provides important insight into the nature of the cerebral insult and into the patient's prognosis. We review the literature available on this topic, discuss the role of imaging and the value of specific imaging techniques, and show illustrative imaging examples in both pediatric and adult patients. These cases include perinatal asphyxia, carbon monoxide poisoning, inborn errors of metabolism, insulin overdose, drowning, and cardiac arrest.

CONCLUSION

Characteristic patterns of hypoxic-ischemic and hypoglycemic encephalopathy reflect the type of insult and tissue susceptibility. An understanding of these patterns allows the appropriate evaluation of such patients for prognosis and management decisions.

KEY WORDS: HIE, hypoxia, hypoglycemia

Scientific Exhibit 106**"Tumors Don't Always Read the Textbook": Confounding Appearances of Pediatric Posterior Fossa Tumors**

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PURPOSE

The more common pediatric posterior fossa neoplasms, including juvenile pilocytic astrocytoma, ependymoma, and primitive neuroectodermal tumor (medulloblastoma), often demonstrate characteristic imaging appearances.

MATERIALS & METHODS

A juvenile pilocytic astrocytoma within the posterior fossa frequently presents as a "cyst and enhancing mural nodule" within a cerebellar hemisphere. The typical medulloblastoma is a midline hyperdense homogeneously enhancing mass effacing the fourth ventricle. An ependymoma commonly demonstrates signal heterogeneity and a propensity to expand the fourth ventricle and extend through the foramina of Luschka and Magendie. Though not entirely sensitive or specific, these distinguishing features, when present, allow for a presumptive diagnosis. The presumptive diagnosis guides further evaluation and management until a definitive diagnosis is accomplished. Occasionally, an alternative tumor type may mimic one of these classic appearances, thus confounding the differential diagnosis.

RESULTS

We will review examples of pediatric posterior fossa tumors whose imaging best exemplifies the features of their final diagnosis as well as several cases in which those features are mimicked by other tumors.

CONCLUSION

The imaging of these mimics will be analyzed to highlight additional characteristics which may provide clues to the correct diagnosis in such challenging cases.

KEY WORDS: Medulloblastoma, juvenile pilocytic astrocytoma, ependymoma

Scientific Exhibit 107

Neurologic Compromise in Extramedullary Hematopoiesis

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PURPOSE

Pictorial demonstration of the intracranial and intraspinal neuroimaging of involvement by extramedullary hematopoiesis.

MATERIALS & METHODS

Three patients were identified from the hospital radiology data base system with CNS extramedullary hematopoiesis. One patient had intracranial and paraspinal involvement and 2 had para and intraspinal involvement without intracranial involvement. Other associated findings such as pulmonary hemosiderosis, calcified spleen, and bony changes were present. Multiple diagnosis modalities such as plain film, 3D CT scan, ultrasound, MR imaging and Technetium 99 sulfur colloid scan will be shown.

RESULTS

Patient 1 is an eight and a half-year-old female with myelofibrosis who initially presented with anemia and has since then progressed to pancytopenia. She presented for cranial imaging due to headaches. She is on a regular red cell transfusion program. CT and MR imaging as well as sulfur colloid scan were positive for intracranial involvement of extramedullary hematopoiesis. The other two patients had imaging documentation of intraspinal deposits of extramedullary hematopoiesis.

CONCLUSION

Intracranial extramedullary hematopoiesis is rare but has been reported in multiple etiologies. We show one case and demonstrate paraspinal involvement in that case and intraspinal involvement in 2 other patients. We demonstrate CNS features and in addition, extra CNS features which may suggest the diagnosis or confirm it.

KEY WORDS: Extramedullary hematopoiesis, intracranial, intraspinal

Spine 108-115

Scientific Exhibit 108

Imaging of Nerve Roots: A Pictorial Essay

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PURPOSE

To review the normal anatomy and provide an overview of the pathologic processes affecting the nerve roots.

MATERIALS & METHODS

The normal anatomy and spectrum of diseases of the nerve roots will be reviewed with the help of myelograms, 16 detector CT images, and MR images. The spectrum of pathologic processes that affect the nerve roots will be demonstrated.

RESULTS

Several pathologic processes including inflammatory, traumatic, neoplastic, and congenital conditions afflict the nerve roots. Examples presented include arachnoiditis, metastases, neurofibromatosis, pseudomeningocele due to avulsion, charcot marie tooth disease.

CONCLUSION

A practical discussion of the nerve roots can benefit the practicing radiologist in formulating a reasonable differential diagnosis.

KEY WORDS: Spine, nerve roots

Scientific Exhibit 109

Nonglial Tumors and Tumor-Like Lesions of the Spinal Cord: MR Features with Intraoperative and Pathologic Correlation

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PURPOSE

The purposes of this scientific exhibit are to increase the knowledge of magnetic resonance (MR) imaging features of nonglial tumors and tumor-like lesions of the spinal cord (including hemangioblastomas, dysembryogenetic tumors, intramedullary schwannomas, melanocytic tumors, intramedullary spinal cord metastases, cavernous malformations, and other tumors), that constitute about 40% of all spinal cord tumors and neoplasms, as well as to underscore the possibility of a reliable presurgical diagnosis in most of

nonglial tumors and tumor-like lesions of the spinal cord, when MR features are correlated with clinical, and epidemiologic data.

MATERIALS & METHODS

From a review of 140 patients with spinal cord neoplasms with definite histologic diagnosis examined by MR imaging since 1988, clinical and MR imaging features of 70 patients with nonglial tumors and tumor-like lesions are presented. Eleven patients had hemangioblastomas, 14 patients had 16 cavernous malformations, 20 patients had intramedullary spinal cord metastases, 18 patients had dysembryogenic tumors, 2 patients had intramedullary schwannomas, 2 patients had melanocytic tumors, and three patients with other tumors. Fifty-eight patients had been operated in the same neurosurgical institution. In 69 patients, presurgical gadolinium-enhanced MR imaging was available. The duration of clinical and radiologic postoperative follow-up ranged from 9 months to 14 years (mean, 7.2 years).

RESULTS

In the patients of hemangioblastomas, cavernous malformations, and dysembryogenic tumors, MR features allowed a reliable, and correct diagnosis. In the patients with intramedullary spinal cord metastases, only the knowledge of the primary neoplastic lesion could allow the correct diagnosis, although the localization in the conus/epiconus was characteristic.

CONCLUSION

In the patients with less common tumors and tumor-like lesions, the possibility of presurgical MR diagnosis has been less achievable.

KEY WORDS: Spinal cord tumors, nonglial tumors and tumor-like lesions, MR imaging

Scientific Exhibit 110

Spinal Cord Lesions: Neuroimaging Spectrum with Clinical/Neuropathology Correlation

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PURPOSE

To assess the neuroimaging findings of a wide variety of intramedullary spinal cord lesions and correlate with clinical diagnosis/neuropathology.

MATERIALS & METHODS

One hundred six patients with neuroimaging findings of intramedullary spinal cord lesions were included in this study. The neuroimaging studies including spine MR imaging with and without contrast, spine CT scan, and spinal arteriogram.

RESULTS

Nonneoplasms group (n = 78): multiple sclerosis (n = 40), syringohydromyelia (n = 20), acute disseminated encephalomyelitis (n = 5), ischemia/infarct (n = 5), venous

congestion from dural AVF (n = 3), hemorrhage related to epidural catheter (n = 3), sarcoidosis (n = 2). Neoplasms group (n = 28): ependymoma (n = 10), astrocytoma (n = 2), anaplastic astrocytoma (n = 1), glioblastoma multiforme (n = 1), oligodendroglioma (n = 1), metastasis (n = 11), lipoma (n = 2).

CONCLUSION

Neuroimaging, particularly spine MR imaging provides precise localization and characterization of the spinal cord intramedullary lesions and leads to successful patient's management. The location and neuroimaging pattern of each group's patients and clinical as well as neuropathologic findings will be presented in this exhibit.

KEY WORDS: Spine, intramedullary, lesions

Scientific Exhibit 111

MR Imaging of Inflammatory Demyelinating Polyneuropathy

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PURPOSE

Guillain-Barre syndrome (GBS) and chronic inflammatory demyelinating polyneuropathy (CIDP) are classified in autoimmune inflammatory polyradiculoneuritis which cause demyelination of the peripheral nerves. Clinically, GBS shows transient progress, while CIDP shows chronic progress including repeated aggravation and improvement. We present MR findings of these diseases, and the relation of clinical symptom/therapeutic effect and image changes.

MATERIALS & METHODS

Spinal MR imaging was performed in 8 GBS cases (6 male and 2 female; age range, 3-70 years) and 11 CIDP cases (6 male and 5 female; age range 15-76 years) with 1.5 T MR unit (Siemens, Magnetom Vision/Symphony). We collated MR findings with clinical symptoms and electrophysiologic findings.

RESULTS

Swelling and enhancement of cauda equina were common image findings of GBS (7/8) and CIDP (7/11). Nerve root enhancement was recognized with ventral predominance or diffuse, and which localization reflected motor or sensory disturbance. This MR finding showed different progress in GBS and CIDP. After symptom improvement, nerve root enhancement disappeared in GBS, but remained in CIDP. In initial MR imaging of CIDP, weak swelling and diffuse T2 high signal intensity extending along the affected brachial and lumbar plexus was characteristic (10/11). This finding was not recognized in any GBS (0/8). Especially, in CIDP patient with long affection period, nerve plexus/peripheral nerve showed nodular swelling and reflected regression. Nodular swelling seemed to reflect chronic change (remyelination). These MR findings remained after symptom improvement and were not valuable for evaluation of therapeutic effect. On nerve conduction velocity study (NCVS), improvement of conduction block and conduction velocity

drop related to the symptom improvement. For evaluation of therapeutic effect in CIDP, NCVS was more useful than MR imaging.

CONCLUSION

Clinically, GBS and CIDP may show similar clinical symptoms at their early stage. MR imaging shows characteristic finding in these diseases, and is a useful tool to distinguish GBS from CIDP at early stage.

KEY WORDS: Polyneuropathy, Guillain-Barre syndrome, CIDP

Scientific Exhibit 112

Spinal Cord Pseudoneoplasms

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When evaluating the MR images of a patient with a spinal cord lesion differentiation between neoplasms and tumoral mimics is not always easy. A wide variety of spinal cord lesions (demyelinating diseases, infections, inflammatory diseases, infarctions, vascular malformations, toxic/metabolic disorders) may simulate a cord neoplasm. It is the primary role of the radiologist to narrow the differential diagnosis guided by the patient history and the imaging features of the lesion. Pseudoneoplasms are those nonneoplastic conditions that may lead to enlargement, abnormal signal, or enhancement in the spinal cord. Lack of cord enlargement usually excludes a neoplasm. The distinction between neoplasm and pseudoneoplasm is more difficult when cord enlargement is present. Additional imaging such as brain MR imaging is often helpful in narrowing the differential diagnosis, and selected cases may benefit from spinal MR angiography to identify abnormal intradural vessels. In this exhibit we present several cases with nonneoplastic cord lesions that simulate cord tumors and we highlight the ancillary imaging findings that may contribute in making the distinction

KEY WORDS: Cord, pseudoneoplasm, neoplasm

Scientific Exhibit 113

MR Findings of Acute Vertebral Compression Fractures: Correlation with Cement Distribution Patterns on Percutaneous Vertebroplasty

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PURPOSE

We described MR findings of acute vertebral compression fractures and correlated those with the distribution patterns of injected cement on percutaneous vertebroplasty (PVP). We performed contrast-enhanced MR imaging in addition to T1- and T2-weighted imaging to classify the vertebral lesions.

MATERIALS & METHODS

Twenty-three patients with 34 vertebral compression fractures due to osteoporosis, and 3 patients with 3 metastatic compression fractures were studied. The areas with vertebral lesions were classified into 4 patterns based on MR findings: 1) diffuse contrast-enhancing (CE) area (edema or inflammation); 2) cleft sign; 3) nonenhancing (NE) area (probably due to osteonecrosis); 4) metastatic tumors. Based on MR findings, 34 osteoporotic fractures were divided into 4 types: Type1: CE area only; Type 2: CE area + cleft; Type 3: CE area + NE area; Type 4: CE area + NE area + cleft. The distribution of injected cement was classified into 3 patterns based on post-PVP CT and plain radiographs: 1) trabecular pattern; 2) solid pattern; 3) mixed pattern (trabecular and solid patterns mix). MR findings were correlated with distribution patterns of injected cement.

RESULTS

All of type 1 fractures showed the trabecular pattern. All of type 2, type 3, and type 4 fractures showed the solid or mixed patterns, except for one type 2 fracture. All metastatic fractures showed the solid or mixed patterns. One patient who had type 3 fracture at Th12 showed only moderate pain improvement after injection of cement into CE area on first PVP procedure. Additional cement injection within the NE area on second procedure made remarkable improvement.

CONCLUSION

Cement distribution patterns on PVP can be predicted from MR findings. Contrast-enhanced MR in addition to T1- and T2-weighted imaging is important to detect cleft or osteonecrosis, in which cement fills in a similar solid distribution pattern. Sufficient filling of those portions may be important for optimal pain control.

KEY WORDS: Vertebroplasty, MR imaging, cement

Scientific Exhibit 114

Complications of Anterior Neck Surgery/Instrumentation for Cervical Disks and Spondylosis

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New York, NY

PURPOSE

The purpose of this study was to evaluate the incidence, clinical course, and imaging appearance of complications of anterior neck surgery for cervical spondylosis and disk disease.

MATERIALS & METHODS

Retrospective review of the anterior cervical surgeries performed during the period 2001-2003 disclosed 30 patients with major or minor postoperative difficulties affecting the spine and anterior neck. The clinical courses and imaging studies (CT and MR imaging) of these patients formed the study material.

RESULTS

The 30 patients represent approximately 8% of the anterior cervical surgeries performed during the study period. The difficulties observed included suboptimal placement of screws and plates (7), migrated screws and plates (5), migrated cages and strut grafts (5), infection of the spine (2), infection of the anterior neck (2), hematomas (2), dysphagia (3), esophageal perforation (1), and vocal cord paralyses (3). This experience led to a protocol for evaluating the recently operated and the remotely operated patient, and has given us an improved understanding of the imaging manifestations of these complications.

CONCLUSION

Complications of anterior cervical surgery for spondylosis and disk disease are relatively frequent. Imaging studies help to detect and characterize them, particularly when patients are followed by established protocols.

KEY WORDS: Spinal surgery complications, spine cervical, spinal instrumentation cervical

Scientific Exhibit 115**Angiography CT vs Conventional CT in the Evaluation of Cervical Spine Trauma**

Parkey, J. • Yang, L. • Perez, C. L. • Anderson, J. • Lane, T. • McNulty, A. • Chason, D. P.

University of Texas Southwestern Medical Center
Dallas, TX

PURPOSE

To demonstrate the clinical utility of angiography CT (ACT) for the evaluation of the bony cervical spine in the trauma patient.

MATERIALS & METHODS

Angiography CT scans of the cervical spine were acquired in multitrauma patients undergoing emergent cerebral/cervical angiography using rotational angiography sequences with or without contrast. Postprocessing and review of the cervical spine in standard orthogonal planes was performed on a 3D workstation. Comparison was made with conventional CT including sagittal and coronal reconstructions.

RESULTS

Angiography CT demonstrates fractures of the cervical spine equal to that of conventional CT. Although the evaluation of the soft tissues is limited, the ability of ACT to be acquired during angiography may obviate the need for conventional CT in patients with multiple traumatic injuries who require emergent angiography.

CONCLUSION

Angiography CT provides a fast, accurate, and novel way to assess bony cervical spine pathology in a multitraumatic patient and may preclude the need for conventional CT in certain clinical situations.

KEY WORDS: Cervical spine, trauma, CT

Computer Assisted Exhibits 1-40

Exhibit Hall 4B (Level 4)

Monday, June 7

6:00 PM – 9:00 PM

Tuesday, June 8 - Thursday, June 10

6:30 AM - 9:00 PM

Friday, June 11

6:30 AM – 11:45 AM

NOTE: Unless otherwise indicated, all Computer Assisted Exhibits can be viewed from any computer. A missing Computer Assisted Exhibit number indicates an abstract has been withdrawn.

**Adult Brain
1-15**

Computer Assisted Exhibit 1

Physiology of Cerebral Perfusion Autoregulatory Mechanisms and their Evaluation with State-of-the-Art Neuroradiologic Imaging

Radaideh, M. M.¹ • Walker, M. T.¹ • Curtin, K. R.¹ • Carroll, T. J.¹ • Shaibani, A. S.¹ • Derdeyn, C. P.² • Russell, E. J.¹

¹Northwestern University, Chicago, IL, ²Mallinckrodt Institute of Radiology, St. Louis, MO

PURPOSE

The purpose of this computer-assisted educational exhibit is: 1) To discuss the physiology of cerebral perfusion autoregulatory mechanisms and demonstrate how they are independent and not interchangeable. 2) To discuss the responses of the brain to altered cerebral perfusion and explore the change that occurs in acute and chronic steno-occlusive cerebrovascular disease. 3) To examine the different physiologic rationales for current state-of-the-art imaging of cerebral hemodynamics and to review some of the literature correlating these methods. 4) To critically examine the association of these different manifestations of hemodynamic impairment with stroke risk. 5) To demonstrate current clinical applications of MR perfusion (MRP) and CT perfusion (CTP) in the setting of acute and chronic steno-occlusive disease.

MATERIALS & METHODS

Physiologic imaging tools have provided an in vivo window for the study of central nervous system perfusion and autoregulation, particularly in the areas of acute and chronic cerebral steno-occlusive disease. A variety of imaging techniques have been developed for the indirect assessment of cerebral hemodynamic status. Understanding the principles of cerebral perfusion and autoregulation are critical for the

accurate interpretation of MRP and CTP studies. In this exhibit we will review normal cerebral perfusion, the different physiologic arms of cerebral hemodynamic autoregulatory mechanisms and describe the changes that occur in acute and chronic steno-occlusive disease. We will use illustrations and flowcharts to streamline the understanding of these principles. This knowledge then will be applied to describe and understand MRP, CTP, and diamox stress perfusion studies. Clinical MRP and CTP cases will be used to demonstrate some of these aspects.

RESULTS

By the end of this exhibit the reader should understand normal cerebral perfusion and will be familiar with the three arms of cerebral perfusion and autoregulation: the vasodilatory mechanism, the capillary capacitance mechanism, and O₂ extraction regulation. The user also will understand the independence of these factors and how they are manifested in acute and chronic steno-occlusive cerebrovascular disease. Examples of altered cerebral perfusion, employing imaging modalities including MRP and CTP, illustrate these principles.

CONCLUSION

Important dynamic physiologic processes involving the cerebrovascular system can be studied using a variety of noninvasive imaging tools including MRP and CTP. These tools have broadened our understanding of the pathophysiology of disorders of the central nervous system, particularly ischemia. Armed with this new understanding, novel diagnostic and therapeutic algorithms are evolving that integrate these powerful tools and improve patient care.

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KEY WORDS: Cerebral autoregulation, cerebral hemodynamics, brain

Computer Assisted Exhibit 2 **Moved to POSTER 13A**

Feasibility for Population-Based MR Angiography Screening for Unruptured Intracranial Aneurysms: Initial Results from the Northern Manhattan Study

Dumitriu, D. • Lin, E. • Chao, K. • Lignelli, A. • DeLaPaz, R. • Brown, T. • Sacco, R. • Pile-Spellman, J.

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PURPOSE

To assess the prevalence of unruptured intracranial aneurysms (UIAs) in the population by MR angiography (MRA) screening in a prospective, randomly derived community population. Although the prevalence of UIAs is unknown, estimates in the general population range from 0.2% to 5%. Estimates for UIAs in the elderly population

based on prospective, randomly derived screening do not exist. Such a screening has not been undertaken as of today, owing to its inherent challenges, especially in the form of various threats to validity. True incidence of UIA is needed for planning of clinical trials for UIA treatment.

MATERIALS & METHODS

Participants in the Northern Manhattan Study, a prospective, randomly derived, population-based community cohort, received an MRA using a 1.5 T scanner (pulse sequence acquisition of 3DI-MRA, TE/TR 2.7/20 ms, FOV 150 x 150, flip 25°, resolution 228/512). Source images were post-processed in an Easy Vision (Philips Medical System) and viewed as 3D MIPs. Two radiologists read each MRA independently and their findings are compared. For each aneurysm found, the location and size was documented. In addition, the reviewer rated the likelihood of having diagnosed the aneurysm correctly according to the following scale: low likelihood (likely infundibulum, possibly aneurysm), moderate likelihood (likely aneurysm, less likely infundibulum), high likelihood (very likely aneurysm) and definite aneurysm.

RESULTS

One hundred twenty-four subjects have received an MRA to date. (Approximately 1400 subjects are projected to be imaged over the next 5 years). The 84 MRAs that were read by two independent reviewers were performed on subjects ranging between 57 and 97 years of age (mean 73, median 73) of which 42 (50%) were males; 26 (31%) subjects identified themselves as white, 30 (36%) as black, 21 (25%) as Hispanic, and 7 (8%) as other. The crude prevalence of any possible UIA was 11% for reviewer 1 and 12% for reviewer 2. Reviewer 1 found 5 (6%) UIAs rated low likelihood and 4 (5%) UIAs rated moderate likelihood. Reviewer 2 found 8 (10%) UIAs rated low likelihood and 2 (2%) UIAs rated moderate likelihood. All documented UIAs were less than or equal to 4 mm and no aneurysms were rated high likelihood or definite. Interrater agreement was 23% as determined by kappa test.

CONCLUSION

According to our preliminary findings, the prevalence of UIAs in the general population is somewhat higher than previously reported. However, confidence in assessing an aneurysm below 5 mm appears to be limited using MRA, as reflected both by the reviewers' self-reported likelihood of diagnosis and the low interrater agreement. Strategies are being explored to increase interrater agreement.

KEY WORDS: Aneurysm, MR angiography, screening

Computer Assisted Exhibit 3

Progressive Venous Sinus Thrombosis Demonstrated with Auto-Triggered Elliptic Centric-Ordered MR Venography

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Toronto, ON, CANADA

PURPOSE

Auto-triggered elliptic centric-ordered MR venography (ATECO MRV) has been shown to be superior for visualization of the intracranial venous system. We present a case of dural venous sinus thrombosis in a 28-year-old male with Behçet's disease. The progression of the intracranial venous thrombosis is seen clearly in multiple subsequent ATECO MRV studies. Three-dimensional tools available in this MR technique were extremely important in helping to visualize these abnormalities.

MATERIALS & METHODS

The ATECO MRV performed on admission showed an extensive thrombus within the superior sagittal sinus and both transverse sinuses. Part of this thrombus appeared to be acute, and part subacute. Intravenous anticoagulation (heparin) was initiated. A second ATECO MRV was performed after the occurrence of a seizure, and it showed the progression of the clot in the left sigmoid sinus (acute extension of the clot). The third ATECO MRV performed after clinical deterioration despite medical therapy showed progression of sinovenous thrombosis with occlusion of the petrosal and straight sinuses and retrograde flow through enlarged superior ophthalmic veins (SOV). MR imaging of the brain at this time also showed venous congestive encephalopathy. Heparin-induced thrombocytopenia (HIT) was diagnosed eventually and alternative anticoagulant therapy was established. The fourth MR examination including ATECO MRV demonstrated improvement in the appearance of the brain as well as diminished retrograde flow through the SOV.

RESULTS

In this patient, the progression and regression of the dural sinus thrombosis were demonstrated with details, helping to detect complications and to choose an adequate management.

CONCLUSION

The ATECO MRV is a precise noninvasive diagnostic method that helps to visualize the intracranial dural sinuses.

KEY WORDS: Dural venous sinus, thrombosis, MR imaging

Computer Assisted Exhibit 4

StrokeCheck: A Community Education and Screening Program. Results from 2001-2004

Agran, S. D.

Sun City Imaging
Scottsdale, AZ

This video and audio presentation will take you step-by-step through what a StrokeCheck education and screening program entails, and how you can host a StrokeCheck program in your hospital. A videoclip of an actual StrokeCheck screening will be viewed

KEY WORDS: StrokeCheck, education, stroke

Computer Assisted Exhibit 5

Diffusion Imaging: A New Clinical Tool in Eclampsia

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PURPOSE

To validate diffusion-weighted MR imaging in predicting the evolutive course of brain edema, and to establish its pathophysiology in patients with eclampsia/severe preeclampsia.

MATERIALS & METHODS

Twenty-seven patients with clinical diagnosis of eclampsia/severe preeclampsia and T2 hyperintense brain lesions at routine MR imaging were evaluated at hospital admission and 8 weeks later either on a per patient and per anatomical location basis.

RESULTS

For per patient analysis, the sensitivity, specificity, positive and negative predictive values, and accuracy of diffusion-weighted MR imaging were 100% (95% CI: 82%, 100%), 60% (95% CI: 17%, 93%), 92% (95% CI: 72%, 99%), 100% (95% CI: 83%, 100%), and 93% (95% CI: 74%, 99%), respectively. For per anatomical location analysis, the sensitivity, specificity, positive and negative predictive values, and accuracy of diffusion-weighted MR imaging were 100% (95% CI: 95%, 100%), 67% (95% CI: 24%, 94%), 98% (95% CI: 91%, 100%), 100% (95% CI: 95%, 100%), and 98% (95% CI: 92%, 100%), respectively. There was close agreement between diffusion-weighted MR imaging and follow-up MR imaging in the prediction of reversible brain lesion either on a per patient (k value, 0.71) and per anatomical location basis (k value, 0.79). Diffusion-weighted MR imaging demonstrated significant increase of water mobility in abnormal regions when compared to normal appearing brain in patients of reversible group (1.34 ± 0.10 vs $0.79 \pm 0.08 \text{ mm}^2/\text{s}$; $P < 0.001$). In the irreversible group, there was restricted water diffusion, consistent with cytotoxic edema and early brain infarction in three of five patients.

CONCLUSION

Diffusion-weighted MR imaging can predict successfully the evolutive course of brain edema at acute setting in these patients. Our findings indicate that brain edema is vasogenic, thus supporting cerebral microvascular dilatation as the principal pathophysiologic mechanism of brain edema in eclampsia/severe preeclampsia. Ischemic/cytotoxic edema could be observed less commonly, however.

KEY WORDS: Diffusion, eclampsia, MR imaging

Computer Assisted Exhibit 6

Functional Anatomy of the Basal Ganglia

Salamon, N. • Salamon, G. M.

David Geffen School of Medicine at the University of California Los Angeles
Los Angeles, CA

PURPOSE

This is a learning tool for the anatomy of the basal ganglia to understand morphology of the basal ganglia and the connection to the different parts of the cortex.

MATERIALS & METHODS

The presentation is divided into three parts. Part one presents the morphologic and functional anatomy of the basal ganglia. Axial, coronal, and sagittal MR images are demonstrated compared to the anatomical specimen. Part two is the vascular anatomy of the basal ganglia. Part three shows clinical cases of the basal ganglia. The variety of disease seen in basal ganglia is presented, including tumor, ischemia, hemorrhage, infection, metabolic or degenerative disease including Wilson's disease, mitochondrial disease, and multisystem atrophy. Clinical symptoms of each case and MR findings will be correlated.

RESULTS

The interactive program helps the viewer to understand not only the morphology and vascularization of these structures, but also the functional connection of the basal ganglia.

CONCLUSION

This presentation will be a useful tool to understand the anatomy and functional connection of the basal ganglia.

KEY WORDS: Anatomy, basal ganglia

Computer Assisted Exhibit 7

High-Resolution Structural Findings, with Global and Regional Spectroscopic and Diffusion Tensor Imaging Changes, in Pretransplant Hepatic Encephalopathy: A 3 T MR Study

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PURPOSE

To evaluate structural and functional brain changes in pre-hepatic transplant patients, and consider how they relate to disease pathogenesis.

MATERIALS & METHODS

a) MR imaging - A 3 T study, to include pre and postcontrast axial and coronal T1, fast spin-echo (FSE) T2, fast fluid-attenuated inversion-recovery (FLAIR) (TR = 6000 ms, TI = 1800 ms) and diffusion tensor imaging (DTI), providing full tensor mapping. b) MR spectroscopy - Single voxel and multivoxel regions of interest (ROI) were placed on normal appearing white matter (WM) within corona radiata in left parietal lobe, and abutting left cingulate gyrus.

RESULTS

MR imaging: focal T1- and T2-weighted hyperintensities, involving bilateral globus pallidus, and subthalamic nuclei, were demonstrated; in diffusion-weighted imaging no gross abnormalities were observed. Quantitative global DTI data: ADC increased = $(10.3 \text{ mm}^2/\text{s}): 0.85 \text{ vs } 0.77 \pm 0.2$ for normal. FA decreased = $0.20 \text{ vs } 0.24 \pm 0.01$ for normal; similar changes were obtained from ROI analysis in the globus pallidus (GP). MR spectroscopy: Subcortical WM voxel placed in left parietal lobe, and abutting left cingulate gyrus: myoinositol = absent; choline decreased; glutamate plus glutamine increased.

CONCLUSION

The present study combines high-field MR imaging with MR spectroscopy and diffusion tensor imaging data to show: 1. Generalized and regional structural and functional abnormalities. Structural changes include basal ganglia SI changes as described previously. 2. ADC data indicate both regional and global increases reflecting cerebral edema. 3. FA data indicate both regional and global decreases consistent with fiber destruction. 4. MR spectroscopy changes indicate marked, selective changes in neurometabolites, occurring in structurally normal appearing WM brain parenchyma consistent with expected hyperammonemia and resulting osmolarity changes, or related neurometabolic defects. Further study is planned a) to characterize these changes in an additional sample of hepatic encephalopathy patients; b) to evaluate their evolution correlated with posttreatment outcome.

KEY WORDS: Hepatic encephalopathy, neurometabolic, 3 T

Computer Assisted Exhibit 8

Separate Quantification of Lactate and Lipid in Treatment-Naive High-Grade Gliomas Using Three-Dimensional MR Spectroscopy

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PURPOSE

Lactate and lipid are thought to be sensitive markers of tissue hypoxia and necrosis, respectively, and may therefore aid in assessing tumor grade and response to radiation therapy in gliomas. However, separate identification and quantification of lactate and lipid using proton (^1H) MR spectroscopic (MRS) imaging has been difficult due to their close resonance. The purpose of this study was to use a new ^1H MRS method to separately quantify levels of lactate and lipid in newly diagnosed glioma patients.

MATERIALS & METHODS

Fourteen untreated glioma patients (6 grade IIIs and 8 grade IVs) were studied prior to surgery. All patients underwent either subtotal or gross total resection. The protocol consisted of conventional MR imaging followed by 3D J-difference lactate-edited MRS using a point resolved spectral selection (PRESS) volume selection technique that incorporated a two-cycle band selective inversion with gradient dephasing (BASING) pulse previously developed in our laboratory (1). Levels of lipid (lip) and lactate (lac) were quantified automatically using software developed in-house (2). Two parameters were used to compare between grades: maximum lip/lac (as given by the peak heights), and the number of voxels with significant levels of lip/lac (denoted lip+ or lac+ voxels). Only peaks with a height greater than four times the standard deviation of noise were considered significant. Nonparametric Wilcoxon rank tests were performed with a significance threshold of $p < 0.05$ to test differences between grades.

RESULTS

Lipid: All grade IVs and 3/6 grade IIIs showed lipid. The maximum lip ranged from 3.16 to 9.24 in grade IIIs and from 7.08 to 42.97 in grade IVs, with median values of 4.73 and 15.14, respectively. The number of lip+ voxels ranged from 0 to 11 in grade IIIs and from 5 to 64 in grade IVs, with median values of 0.5 and 19, respectively. The difference between grades in both parameters was significant ($p = 0.0127$ and $p = 0.0078$, respectively). **Lactate:** All grade IVs and 5/6 grade IIIs showed lactate. The maximum lac ranged from 3.88 to 51.54 in grade IIIs and from 4.73 to 19.37 in grade IVs, with median values of 4.94 and 11.32, respectively. The number of lac+ voxels ranged from 0 to 26 in grade IIIs and from 4 to 53 in grade IVs, with median values of 4.5 and 14.5, respectively.

CONCLUSION

Our preliminary data suggest that mobile lipid may reliably differentiate grade IV from grade III gliomas. Although lactate was present in both grades, the amount was significantly higher in grade IVs. Future studies will investigate whether quantitative analysis of lipid and lactate can predict tumor grading and assess response to radiation therapy.

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KEY WORDS: Proton spectroscopy, glioma, lactate

Computer Assisted Exhibit 9

Review of Rim-Enhancing Lesions

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PURPOSE

To discuss and compare the various etiologies of rim-enhancing lesions on CT and MR imaging.

MATERIALS & METHODS

Fifteen patients studied underwent pre and postcontrast imaging and MR imaging with conventional T1- and T2-weighted spin-echo and gadolinium-enhanced T1-weighted and susceptibility-sensitive gradient-echo (GRE) sequences. The results were biopsy/autopsy proven.

RESULTS

A spectrum of pathology including metastatic lesions, abscesses, cryptococcosis, chronic hematoma, lymphoma, vascular malformations, and granulomatous diseases like TB, demyelinating diseases like MS, show rim enhancement, a few of them showing a predilection for specific locations.

CONCLUSION

Rim enhancement is seen in a variety of pathologic conditions and it is important to know the differential diagnosis.

KEY WORDS: Rim enhancement, metastatic lesions, infection

Computer Assisted Exhibit 10

Registration Engine: Integrating Automated Coregistration of Serial MR Imaging into the Clinical Workflow

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PURPOSE

Comparison of serial MR studies is facilitated when the studies are coregistered. We demonstrate an automated system for performing coregistration on 3D volumetric data so that coregistered studies are available for review on PACS in a clinically timely manner.

MATERIALS & METHODS

Three-dimensional postcontrast T1-weighted images of the brain were obtained at 1.5 T using a quadrature head coil. Sequence parameters were components of the registration engine and include: 1) Unix workstation, 2) MEDx software, 3) Brain template and local archive of prior studies, and 4) Network interface to scanners and PACS archive.

RESULTS

A brief description of the system configuration is as follows. Briefly, MEDx acts as a DICOM catcher on the workstation. A shell script polls for incoming data. Arrival of a new study triggers the engine to search for prior brain volumes on that patient. If a prior study is identified, MEDx invokes an automated registration algorithm (FLIRT) to coregister and resection the new data to match the prior. These resectioned data are stored on the local archive. In addition, the resectioned data are given a new study description and sent as a new DICOM study to PACS where it is available for clinical review. No user interaction is required. If no prior scan is available on a patient, the initial study is sectioned to match a template atlas brain to standardize viewing planes for future studies.

CONCLUSION

It is clear that coregistration of brain data facilitates the interpretation of serial studies, particularly in identifying interval change in tumor size. Here we demonstrate the feasibility of a fully automated "registration engine" which generated coregistered data sets for review on clinical workstations. Not only does this facilitate clinical interpretation, but it provides a reliable foundation for performing tumor measurements in clinical protocols and a database for the development for more sophisticated analyses such as tumor volumetry and 4D segmentation.

KEY WORDS: Registration, neoplasm, segmentation

The authors of this work have indicated the following affiliations/disclosures: Sensor Systems, Inc.: Employee.

Computer Assisted Exhibit 12 (view only at Computer 21)

Two- and Three-Dimensional Atlas of Brain Anatomy

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PURPOSE

The purpose of this work is to develop a computer application for efficient neuroanatomical education. Today's neuroanatomical education is mainly two-dimensional (2D). There are also several tools which provide three-dimensional (3D) anatomical models. Using either of these approaches alone is effective. Suitable tools are necessary that combine both 2D and 3D images and/or models, and use them simultaneously to study neuroanatomy.

MATERIALS & METHODS

An electronic 2D brain atlas was constructed based on the Talairach-Tournoux print brain atlas (4) [as demonstrated by us at ASNR 2001 (2)]. The original material was enhanced

and extended, and the electronic atlas was fully color-coded and labeled with subcortical structures, gyri, and Brodmann's areas. The 2D atlas was registered with a high-resolution MR dataset and a user-friendly tool was built previously for 2D atlas exploration (3). A 3D brain atlas was constructed (1) derived from the 2D electronic Talairach-Tournoux atlas. Both 2D and 3D atlases are put in spatial registration. An interactive computer application is developed for navigation between the 2D axial, coronal, and sagittal atlas-MR imaging and 3D atlas. Interactive labeling of 2D and 3D cerebral structures is provided.

RESULTS

A user-friendly application has been developed for exploration of anatomical structures in 2D and 3D. It contains one main and three reference windows to explore the data and atlas on the orthogonal triplanar and in 3D. The application is developed using Macromedia as an authoring tool and it runs on a standard personal computer. Tools for interactive manipulation of anatomical structures have been developed including rotation, zooming, panning, animation, and structure selection. In addition, tools for interactive querying of structures in the 2D and 3D images or alternatively in the anatomical index are provided. The 3D image also can be labeled interactively with numerous names placed permanently in the image and the labeled image can be saved in an external file. The application operates in two modes: 2D and 3D. In the 2D mode, the user can explore the atlas images simultaneously on axial, coronal, and sagittal plane, and the selected structure of interest is displayed in 3D. In the 3D mode, the 3D structures are explored with an additional display of a 2D orthogonal plane crossing the 3D cerebral models.

CONCLUSION

This application facilitates the study and exploration of 2D cerebral structures in correlation to 3D cerebral structures. It also allows the user to explore 3D structures individually as well as to browse 2D cerebral structures on the triplanar formed by axial, coronal, and sagittal orientations. This user-friendly and affordable application is useful for both medical students to study neuroanatomy and educators to prepare teaching materials.

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KEY WORDS: Brain atlas, MR imaging, 3D

Computer Assisted Exhibit 13 (view only at Computer 21)

Three-Dimensional Atlas of Brain Anatomy and Vasculature

Nowinski, W. L. • Thirunavuukarasuu, A. • Baimouratov, R. • Volkov, I. • Huang, S.

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Singapore, SINGAPORE

PURPOSE

The purpose of this work is to develop an application running on a standard personal computer which will facilitate understanding of three-dimensional (3D) spatial relationships between cerebral vasculature and anatomical structures. An additional objective is to study and rapidly explore individual anatomical structures and/or vascular segments in 3D.

MATERIALS & METHODS

A deformable 3D anatomical brain atlas with subcortical structures (1) was constructed from a two-dimensional (2D) electronic brain atlas. The 2D electronic brain atlas [whose web-based version was demonstrated at the ASNR 2001 (2, 3)] is fully segmented and labeled. It was derived from the Talairach-Tournoux print brain atlas (4) by its digitization, enhancements, and extensions. An anatomical index is constructed and all 3D structures are labeled with their anatomical names. A deformable vascular atlas of cerebral arteries has been constructed from MR angiography (MRA). A new, efficient vascular modeling technique has been developed to provide smooth 3D display and efficient manipulation of vessels. A vascular index is constructed based on Terminologia Anatomica and all vascular segments are labeled with their names. The anatomical and vascular atlases have been coregistered spatially.

RESULTS

A user-friendly application has been developed for exploration of the combined anatomical-vascular atlas. The application is developed using Macromedia as an authoring tool and it runs on a standard personal computer. Tools for interactive manipulation of anatomical structures and vascular segments have been developed including rotation, zooming, panning, animation, and structure selection (of all or individual structures/segments). In addition, tools for interactive querying of structures and vessels in the 3D image or, alternatively, in the anatomical and vascular indices are provided. The 3D image also can be labeled interactively with numerous names placed permanently in the image and the labeled image can be saved in an external file.

CONCLUSION

The 3D anatomical-vascular brain atlas is a user-friendly and affordable tool facilitating to understand 3D cerebral vasculature in correlation to 3D anatomical structures. It also facilitates studying and rapidly exploring of individual anatomical structures and vascular segments. This user-friendly and affordable atlas is suitable for both medical students and educators.

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KEY WORDS: Electronic brain atlas, vascular atlas, anatomical atlas

Computer Assisted Exhibit 14

Hemodynamic Imaging of Cerebral Aneurysms

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PURPOSE

Hemodynamic forces play an important factor in the initiation, progression, and rupture of cerebral aneurysms. Recently, visualization of hemodynamic forces on cerebral aneurysms has been achieved via computational fluid dynamics (CFD) method, but technical difficulties in creating 3D aneurysm models and postprocessing the calculated data is preventing analyzing multiple cases. We developed an efficient system to creating image-based 3D aneurysm models and accessing the calculated data, and present our methods and results.

MATERIALS & METHODS

Among 42 middle cerebral aneurysms detected by 3D CT angiography, 20 aneurysms with high image quality were selected for this study. Rough 3D models were first constructed using Fly-through mode of Alatoview (Toshiba, Japan). These data were exported from Alatoview with an in-house software, and the models were refined with our in-house smoothing application based on the Taubin's mesh smoothing algorithm and the Garland's mesh simplification algorithm. After refining and trimming of a model, an intersecting plane between normal wall and aneurysm wall was made with a 3D CG software. This procedure alleviates the postprocessing the calculated data. Computational fluid dynamics simulations were performed by using our in-house finite element solver under governing equations of mass conservation and Navie-Stokes. Blood was supposed as Newtonian fluid with dynamic viscosity of 0.04 m²/s. Vessel wall was assumed as a rigid wall with no slip condition. For

inlet boundary condition, a typical pulsatile blood velocity of middle cerebral artery (mean: 60 cm/s) measured with transcranial Doppler was used in all aneurysms. The magnitude and distribution of wall shear stress (WSS) were obtained from the calculated data, and compared between aneurysm wall and normal wall. The flow structure in and around the aneurysms was visualized to recognize how the blood flow acts on the aneurysm wall.

RESULTS

It was the systolic phase that WSS acted maximally on aneurysm and normal wall. Maximal WSS in the calculated region that was averaged in 20 aneurysms was 143.9 ± 62.1 dyne/cm², which was about 4 times higher than averaged WSS on normal wall. Maximal WSS appeared at the impingement area or acutely narrowing area (like just after the aneurysmal dilatation). The mean WSS on aneurysm wall at systolic phase was significantly lower than that on normal wall (16.4 ± 11.6 dyne/cm² vs 36.4 ± 12.5 dyne/cm², $p < 0.05$). The magnitude of WSS was influenced largely by the aneurysm shape. Between the Aspect ratio (Dome/Neck) and WSS, a significant negative correlation was recognized ($r = -0.57$, $p = 0.0027$). Flow structure analysis of an aneurysm with high Aspect ratio showed a secondary sluggish flow in the aneurysm. In contrast, blood flowed in orderly fashion in aneurysms with low Aspect ratio.

CONCLUSION

We showed hemodynamic study for a number of cerebral aneurysms was possible with a properly organized application system. High WSS is important in the initiation phase of cerebral aneurysm. But in our 20 middle cerebral aneurysms, WSS action on aneurysm wall was very low. Wall shear stress acts differently in the progression phase of cerebral aneurysms.

KEY WORDS: Cerebral aneurysm, hemodynamics, wall shear stress

Computer Assisted Exhibit 15

Imaging of Developmental Venous Anomalies with Atypical Features

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PURPOSE

Developmental venous anomalies (DVAs, also called venous angiomas) are the most common cerebral vascular malformation and generally have a typical appearance that allows one to make the diagnosis in most cases. Our purpose is to review the MR imaging of DVAs that presented with atypical features.

MATERIALS & METHODS

During a 4-year period we collected a total of nine DVAs that had atypical MR imaging features. Location of the DVAs was not considered in this study. We review the MR studies in these nine patients.

RESULTS

Four DVAs presented in combination with closely related cavernous angiomas that were believed to be secondary to impaired venous drainage from the malformations. Two DVAs presented with associated infarctions that were presumably due to thrombosis of a part of the malformation. One DVA presented with a large acute bleed and since MR venography showed a stenosis of the main draining vein we believe that the hemorrhage was due to increased venous pressure. One did not have a "Medussa head" configuration but involved the cerebral white matter in "fan-like" fashion and drained into an enlarged vein of Galen. The last DVA had multiple pial veins in the cerebellar fissures giving rise to enhancement simulating disease in the subarachnoidal space.

CONCLUSION

Developmental venous anomalies are common and although the diagnosis is straightforward in most cases, atypical features are not uncommon and should be recognized.

KEY WORDS: MR imaging, venous angioma, vascular malformations

Head and Neck 17-22

Computer Assisted Exhibit 17

Interactive Tutorial of Brachial Plexus Imaging

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PURPOSE

This computer-based brachial plexus tutorial covers: a) schematic architecture of the brachial plexus; b) typical imaging protocols; c) MR appearance of the normal plexus; d) identification of key surrounding structures; e) disease categories and specific processes; and f) guides to generating a differential diagnosis.

MATERIALS & METHODS

MR imaging of the brachial plexus was performed on 195 patients between June 1997 and October 2003. Typical imaging protocol covered both brachial plexi and included: large FOV Axial T1- and T2-weighted imaging; smaller FOV sagittal and coronal T1-, T2-, and T1-weighted imaging with fat-saturation. Exported images are included in an interactive shell, which allows the user to navigate through a variety of options from any given screen. Movies were generated from sequential images as well as from surface renderings to provide a greater understanding of three-dimensional structure than that offered by single images.

RESULTS

In this tutorial images of normal brachial plexi are displayed as static images and stacked movies, allowing for a three-dimensional understanding of plexus anatomy. Examples of normal anatomy were selected to illustrate the normal neural elements, branching pattern, and key surrounding structures. Pathology includes intrinsic neurogenic tumors (schwannoma, neurofibroma), axillary nodal disease, contiguous spread of nonnodal tumor such as Pancoast tumor, congenital and degenerative cysts, fibrous lesions (fibroma, desmoid, and fibromatosis), muscle atrophy, inflammatory processes within and around the plexus, and posttraumatic lesions. Interactive links allow correlation of structures with schematic diagrams. The user may view a spectrum of abnormal cases by disease category, location and imaging appearance, with interactive links providing contrasting related or similar-appearing diseases. A quiz mode challenges the user to identify findings and produce a diagnosis.

CONCLUSION

This interactive tutorial allows the user to identify the normal structure and imaging appearance of the brachial plexus, to review differential diagnosis of numerous varieties of cases, and to challenge himself with unknown cases.

KEY WORDS: Brachial, plexus, interactive

Computer Assisted Exhibit 20

Nasolacrimal Duct System: Anatomy, Physiology of Drainage, and Pathologic Correlation

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PURPOSE

In this computer-assisted exhibit we will discuss the nasolacrimal system anatomy, physiology, and pathology. Anatomy will be described and diagrammatically illustrated. A range of adult pathology will be demonstrated using multimodality imaging techniques. Neoplastic and inflammatory diseases with their unique imaging features will be presented and correlated with their pathologic features. A range of postsurgical changes will be demonstrated. Special emphasis will be placed on the usefulness of CT, MR imaging, contrast dacryocystography, dacryoscintigraphy and combined CT/dacryocystography in diagnosis of nasolacrimal system disease. The reader will be introduced also to the technique, indications, and pitfalls of these diagnostic tools.

MATERIALS & METHODS

This computer exhibit will use multilinkage powerpoint format. Netter diagrams will be utilized for anatomical delineation. The various pathologic entities shown are all found in patients presenting to the ophthalmologist with epiphora.

RESULTS

Epiphora is a common ophthalmologic complaint for which a number of imaging modalities are available. With a proper index of suspicion causal conditions arising within the nasolacrimal duct and lacrimal sac can be demonstrated successfully using a variety of techniques. Diseases of this system

including stenoses, calculi, neoplastic conditions, and morphologic abnormalities such as diverticulae can be diagnosed.

CONCLUSION

This computer-assisted exhibit covers evolving concepts in lacrimal outflow obstruction. It is important to understand the anatomy and physiology of the lacrimal drainage system as well as the range of pathologic processes developing in this area.

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KEY WORDS: Nasolacrimal drainage, Epiphora

Computer Assisted Exhibit 21

Virtual MR Endoscopy of the Middle Ear

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An understanding of the 3-dimensional relationships of anatomical structures that make up the tympanic space is critical for radiologists and otolaryngologists to adequately interpret imaging studies in the clinical environment. Three-dimensional reconstructions of the middle ear from clinical imaging studies suffer from limited resolution and relatively large fields of view. We have taken advantage of existing technology employed in the field of MR microscopy to construct a computer-based learning module of middle ear anatomy. Images of a cadaver temporal bone specimen scanned at 9 T after opacification of the middle ear space with dilute gadolinium solution were used to construct the 3-dimensional environment. We have emphasized the spatial orientation of the auditory ossicles, oval window, round window, cochlear promontory, pyramidal eminence, stapedius and tensor tympani muscles, tympanic segment of the facial nerve canal, tympanic recess and facial recess in order to facilitate image interpretation and surgical planning from 2-dimensional images

KEY WORDS: Middle ear, anatomy, temporal bone

Computer Assisted Exhibit 22

Congenital Aural Dysplasia: What the Clinician Needs to Know

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PURPOSE

The purpose of this exhibit is to describe the radiologic findings of congenital aural dysplasia with emphasis on presurgical assessment.

MATERIALS & METHODS

CT scans from the teaching files of two head and neck radiologists at the University of Southern California will be utilized to demonstrate the radiologic findings of congenital aural dysplasia.

RESULTS

Determination of surgical correction of congenital aural dysplasia requires assessment of the atresia plate, relative size and appearance of the middle ear cavity and ossicles, the appearance of the oval and round window, the position of the vertical segment of the facial nerve, and an assessment of the cochlea, vestibule and semicircular canals. In addition, the relative position of the adjacent vascular structures, and surrounding bony structures including the temporal mandibular joint are required.

CONCLUSION

This exhibit will review the pertinent radiologic features seen in congenital aural dysplasia and educate the attendee as to what should be conveyed to the referring physician for treatment.

KEY WORDS: EAC atresia, temporal bone, congenital

**Interventional
24-31**

Computer Assisted Exhibit 24

Elastase-Induced Saccular Aneurysms in Rabbits: Instructions "For the Rest of Us"

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PURPOSE

Although the creation of elastase-induced saccular aneurysms can be quick and easy, for many who have followed instructions from existing publications and word-of-mouth it has been a nerve-racking struggle with poor outcomes. Details on the survival rate of rabbits and the aneurysms' neck-to-dome ratio have yet to be published

until now. We hereby detail the finer points of creating elastase-induced saccular aneurysms in rabbits, making this model easier to reproduce.

MATERIALS & METHODS

The step-by-step procedure will be simulated by using computer interface, and will provide angiographic feedback at every decision-making node. We also will provide instructions on how to evaluate contrast washout, a reliable immediate predictor of successful treatment.

RESULTS

We created over 100 elastase-induced saccular aneurysms in rabbits during the past 2 years. Our initial outcome was below 40%, but improved to 96% as we eliminated most of the pitfalls. Our difficulties were related to the following issues: poor quality rabbit supplier, poor infection prophylaxis, improper anesthesia and recovery procedures, improper catheters, effect of catheter and balloon position on outcome, effect of elastase quality and quantity on outcome, and effect of elastase injection method and rate on outcome.

CONCLUSION

We believe that elastase-induced aneurysms in rabbits have features that make them a better model for certain applications than the surgical model created in dogs or pigs. It is important to make the method reproducible, thus widely available to all interested researchers.

KEY WORDS: Aneurysm, elastase, rabbit

Computer Assisted Exhibit 27

Immediate Evaluation of Angioplasty and Stenting Results in Supraaortic Arteries Using Doppler-Tipped Guide Wire

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PURPOSE

To determine whether intraarterial Doppler (IAD) can be used safely for immediate evaluation of carotid artery stenosis and to evaluate the relationship between blood flow velocities measured with intraarterial and duplex Doppler and degree of stenosis measured angiographically.

MATERIALS & METHODS

The IAD system used consists of a 0.014" Doppler-tipped guide wire (Flowire by Cardiometrics, California) with a piezoelectric transducer operating at 12 MHz mounted at its distal end. The proximal end of the wire is connected to a spectral wave analyzer that displays the pulsed Doppler signal. Sixteen patients (9 men and 7 women) with symptomatic carotid stenosis as shown by an external duplex color Doppler device were examined. When the symptomatic stenotic vessel was entered using the regular femoral approach, an angiographic study was performed and the Flowire was navigated in the catheter to the site of stenosis. Blood flow velocities were recorded proximal to, distal to, and at level of stenosis. Following angioplasty and stenting, the Flowire was reinserted to obtain flow measurements at

level of stenosis. Patients underwent color and spectral Doppler 24 hours, 1 month, 3 month, 6 months, and/or 1 year following the stenting procedure.

RESULTS

For four of sixteen subjects, it was not possible to advance the Doppler-tipped guide wire past the level of the stenosis and velocity measurements with IAD could not be taken. In one patient, the angioplasty procedure was not performed due to induction of a severe vasovagal response. In the remaining subjects, the immediate presten and immediate poststen peak systolic velocities (PSVs) were recorded using the IAD system. The presten peak systolic velocities obtained using IAD were significantly greater compared to the peak systolic velocities obtained following stenting with an average difference of approximately 120cm/s. Similarly, presten measurement of PSV was recorded using conventional duplex Doppler on the same day of the procedure in 8 patients, while same-day poststen duplex Doppler PSVs were recorded in 14 patients. As with IAD, the presten velocities recorded using duplex Doppler were significantly greater than those recorded after the stenting procedure. When comparing IAD and duplex Doppler results, there is a good correlation between PSV measurements obtained following stenting ($R = 0.70$ $p < 0.01$). Both methods show resolution of PSV to "normal" values in 9 patients (56%) following stenting. In all 10 cases, the poststen angiographic results indicate resolution of stenosis to moderate (30-69%) or low ($< 30\%$) grade levels stenosis following the angioplasty and stenting procedure. However, below about 54% stenosis achieved poststen, PSV achieved using IAD and duplex Doppler did not improve considerably. This observation suggests that dilatation of the stent above a certain point does not result in any significant increase in blood flow. During the procedures there were no neurologic complications.

CONCLUSION

In this study, intraarterial Doppler confirmed hemodynamic improvement immediately following stent placement and correlated well with post-CAS duplex Doppler results. Thus, IAD can be incorporated feasibly into CAS procedures for hemodynamic evaluation and complement anatomical information provided by angiography.

KEY WORDS: Intraarterial Doppler, angioplasty and stenting, carotid stenosis

Computer Assisted Exhibit 28

Carotid Stenting for Carotid Stenosis: The Difference between SMART Stent and Easy Wallstent

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PURPOSE

We evaluated the difference between SMART stent and Easy Wallstent of carotid stenting for carotid stenosis.

MATERIALS & METHODS

In a retrospective study among 39 carotid stent procedures we did, 19 carotid stent procedures in 18 patients (17 men, 1 woman; mean age, 72 years; age range, 56-79 years) could obtain follow-up DSA with stenosis. Eighteen (NACET > 60%) were evaluated to assess the peri-postprocedural complication, the expansion of vascular lumen, the embedment of the stent, new stroke after stenting of the difference between SMART stents (n = 11) and Easy Wallstents (n = 7).

RESULTS

In the peri-procedural complication: two cases of symptomatic hypotension were observed in the SMART stent group, but no cases were observed in the Easy Wallstents group. The other complications were not observed in either group. During follow-up (median, 14 months; range 1-44 months) one high-grade restenosis, one ipsilateral stroke, and three dehiscence of stent and vessel wall (42.7%) were observed in the Easy Wallstents group, but no high-grade restenosis, no ipsilateral stroke were observed and all stents were embedded in the vessel wall in the SMART stent group.

CONCLUSION

We think SMART stent is suitable for carotid stenosis as compared with Easy Wallstent, but further controlled follow-up studies of larger samples are required.

KEY WORDS: Carotid stent, SMART, Easy Wallstent

Computer Assisted Exhibit 29

Computer Animation of Catheter Maneuvering in Selective Angiography of Cephalic Arteries

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Expertise in catheter handling is an important factor in timely and successful performance of cerebral angiography. Such expertise is achieved by practice. However, it is essential that the rationale for use of different catheter types and mechanics of manipulation and progression within the lumen of the vessel are understood in advance. Consecutive maneuvers of four basic catheter configurations (Headhunter, Cobra, Mani, Simmons) during selective catheterization are projected within the 3D model of aortic arch and proximal cephalic vessels, using computer animation art. Interactive DVD format makes for easy viewer participation and learning. This teaching exhibit is addressed primarily to neuroradiology fellows who want to learn or improve their skills of basic techniques of catheter navigation during selective neuroangiography

KEY WORDS: Selective neuroangiography, technique, computer animation

Computer Assisted Exhibit 30 (view on Computer 20)

Model-Based Optimal Path Guidance and Remote Operation System for Interventional Neuroradiology Procedures

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PURPOSE

In traditional interventional radiology procedures, how to guide the IR devices in the complex vascular tree to the target positions is a big challenge for the radiologists and needs long time training and good experience. The purpose of this work is to develop a solution that can indicate the optimal manipulation path for the IR device and add-on remote operation system. All the technologies and components are helpful for guiding IR devices in an easier, clearer, and safer way.

MATERIALS & METHODS

The main view provided to the radiologists will be the accurate 3D vascular model based on patient specific data. In pre-operation procedure, the radiologists can do preplanning and manually or automatically plan the optimal motion path of the IR tools. In intraoperation, the position and the orientation of the IR tools inserted into the body are navigated by two projections of angiography images or magnetic tracking system, and displayed on the 3D vascular model. With the motion tracking information, the system will provide real-time guidance for the manipulation of the IR tools so that the tools can reach the target quickly and easily. The remote operation system will provide another option for the radiologist to complete the procedures remotely through the intranet/internet/direct cable connection.

RESULTS

As the first prototype, a vascular phantom is used to prove the method. Using corresponding MR data of the phantom, the 3D digital model is generated and used as the interface for the implementation. An AHB is used by the doctor to navigate the manipulation of the radiologist on the IR device. The motion information is transferred to patient side through cable connection and an AB drives another IR device into the phantom. The tip of the device is tracked. The tracking information then is integrated with the device simulation result so that the position and the orientation of the device can be displayed in the 3D digital model. According to the path planning result, the model will indicate the optimal motion direction to help radiologist to decide following manipulation.

CONCLUSION

The system can provide advantages that the procedure is guided by 3D vascular model so that it is possible that the time of taking radiation image can be reduced; the model-based optimal path guidance technology provides a better way for the radiologist to reach the target in an easier and faster way; the remote operation system provides another option for the radiologist to complete the procedure in remote through the intranet/internet so that the harm caused by frequent radiation can be minimized. The method is first proved by using a vascular phantom. Future work includes more completed validation such as system testing on small animal and real patient.

KEY WORDS: Interventional neuroradiology, remote operation, optimal path

Computer Assisted Exhibit 31**Autocoagulation May Not Be the Treatment of Choice for Sinus and Venous Thrombosis**

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PURPOSE

Despite numerous reports about direct thrombolytic treatment for acute dural sinus thrombosis, there is still some controversy about the guidelines for the treatment. Much previous neurologic literature dictated that anticoagulation is the choice of treatment. The purpose of this investigation is to determine the need and when for thrombolytic treatment.

MATERIALS & METHODS

From January 2001 to December 2003 we have collected 18 patients who suffered acute dural sinus thrombus. Among 12 of these 18 patients who had either edema and/or parenchyma hemorrhage. After a period of heparinization, interventional treatment then was used to salvage the complication. We used thrombolytic treatment of tpa 10 - 15 mg and/or balloon catheters to remove that acute thrombus. Male:female = 7:11. Age: ranging from 34 to 66 years.

RESULTS

All 12 patients recovered completely without deficit except one required surgical removal of a huge intracerebral hematoma. Five patients who had no imaging changes received heparin only, with complete clinical recovery. Follow-up MR venography did show increased collaterals but no definite reopening of dural sinus. One patient developed dural sinus AV fistula after incomplete treatment of thrombosis. Heparin treatment may lead to further hemorrhage or edema if no recanalization of dural sinus, thrombolytic treatment is required.

CONCLUSION

Acute dural sinus venous thrombosis may require thrombolytic and/or mechanical disruption of thrombus to relieve venous congestion to avoid severe consequence such as

edema and/or hemorrhage. Anticoagulation may be used to treat the clinical symptoms but not recanalization of dural sinus but just improving the collateral. MR imaging may be used to identify the timing for thrombolytic treatment. The dural AV fistula may occur after incomplete treatment. Thus, we believe that thrombolytic treatment either from mechanical or liquid lysis may be essential for prevention of this difficult sequelae.

KEY WORDS: Venous, thrombosis, thrombolysis

Pediatrics 32-33

Computer Assisted Exhibit 32**Diffusion Tensor Imaging Analysis of the Growth Pattern of an Intraaxial Tumor at the Cervicomedullary Junction**

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PURPOSE

Brain-stem gliomas are a heterogeneous group of tumors that account for 15% of all pediatric CNS tumors. We report the first case in which diffusion tensor imaging (DTI) was used to investigate the Epstein and Farmer hypothesis regarding the effects of normal brainstem architecture on the growth pattern of low-grade potentially malignant cervicomedullary brain-stem gliomas, and guide surgical planning (1, 3).

MATERIALS & METHODS

Preoperative imaging was obtained on a 1.5 T Symphony (Siemens Medical Systems, Erlangen). Diffusion-weighted, echo-planar images were acquired using a flexible quadrature surface coil placed around the base of the skull for optimal imaging of the cervicomedullary junction. Diffusion tensors were calculated using the SPM diffusion toolbox developed for SPM99 (Wellcome Institute of Neurology, London).

RESULTS

Preoperative DTI imaging demonstrated that caudal growth of the tumor was cylindrical and projected well below the normally positioned pyramidal decussation, to the level of C2 (1). Cephalic growth was bounded superiorly by the decussation of the medial lemnisci and projected dorsally toward the obex. Lateral growth followed the course of the spinal thalamic tracts and pial fibers, and thus was limited to growth into the cerebellar peduncles.

CONCLUSION

Our finding corroborated the Epstein and Farmer hypothesis that the growth patterns of low-grade potential malignant cervicomedullary gliomas are influenced strongly by anatomical barriers in the brain stem(1, 2). This case high-

lights the potential of DTI to demonstrate the tumor's relationship to normal brainstem architecture and enhance the surgical management of brain stem lesions.

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KEY WORDS: Brain-stem glioma, diffusion tensor imaging, cervicomedullary junction tumor

Computer Assisted Exhibit 33

Three-Dimensional FIESTA MR Imaging of the Cerebellopontine Angle and the Inner Ear in Children

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PURPOSE

To present the normal anatomy of inner ear and cerebello-pontine angle (CPA) structures in the pediatric age group, utilizing 3-dimensional fast imaging employing steady-state acquisition (3D-FIESTA) MR imaging. Selected pathology also is demonstrated.

MATERIALS & METHODS

Three-dimensional-FIESTA is a heavily T2-weighted sequence for high spatial resolution, high contrast MR imaging that results in excellent visualization of soft tissue structures coursing through cerebrospinal fluid (CSF) and similar fluids. Therefore it is particularly advantageous in the depiction of the fine structures of the CPA and inner ear. Thin section direct axial and oblique sagittal images were obtained. The majority of the patients imaged were candidates for cochlear implant because of sensory neural hearing loss.

RESULTS

The CPA MR cisternogram provides excellent delineation of the configuration and course of the facial and vestibulocochlear nerves in both their cisternal and canalicular portions. The membranous labyrinth structures including termination of the eighth nerve are well demonstrated. Pathologic cases include absence of the lateral semicircular canal with abnormal vestibule, cochlear malformations, aplasia of the nerves with inner ear malformations, vestibular aqueduct syndrome and labyrinthitis ossificans. Schwannoma and traumatic avulsion of the seventh nerve also are shown. Computed tomography (CT) correlation is provided for several cases. The advantages and disadvantages of the sequence are discussed including banding susceptibility artifact.

CONCLUSION

Three-dimensional-FIESTA is excellent for delineation of normal anatomical structures of the internal auditory canal and membranous labyrinth and evaluation of various pathologies affecting these structures.

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KEY WORDS: 3D FIESTA, MR imaging, inner ear, cerebellopontine angle

Socioeconomics

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Computer Assisted Exhibit 34

MIRIP: An Online Neuroradiology Electronic Teaching File

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MIRC (Medical Image Resource Center) is a new internet repository developed by RSNA that defines standards for data exchange between institutes worldwide. We built a computer server that retrieves DICOM images from PACS and creates a disease database, including ACR code indexes. Electronic teaching file (ETF) cases from the PACS caseload of the National Neuroscience Institute in Singapore were selected and 200 neurologic cases, comprising CT, MR and angiographic images were created. Many of the cases are uncommon and form a distinctive patient population that may be useful for future research. We developed a World Wide Web site that could be seamlessly connected with the RSNA MIRC site storage and query functions, thus linking our ETF to the RSNA search engine. Our system enables DICOM PACS users to create MIRC compliant ETF and shares them with the worldwide neuroradiology community. Neuroradiology images are suited particularly to electronic CME as CT and MR images are natively digital

KEY WORDS: Medical image repository center, neuroradiology, education

Computer Assisted Exhibit 35

Percutaneous Sacroplasty: Indications, Technique, and Results

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PURPOSE

Sacroplasty is a variation of the vertebroplasty technique for treatment of a sacral insufficiency fracture. This computer-assisted exhibit will describe the nature of sacral insufficiency fractures, their etiology and imaging features. It will explore the different treatment strategies including sacroplasty. The indications and technique of sacroplasty will be described in detail including our experience and results with this new novel procedure. The procedure provided symptom relief and resulted in no serious complications.

MATERIALS & METHODS

Although relatively common, sacral insufficiency fractures were described only recently by Lourie in 1982. Osteoporosis is the leading cause, most often afflicting elderly women; other causes include chronic steroid use and radiation exposure. Patients complain of lower back pain that is often acute and may be associated with minimal trauma. In this exhibit we will lay out an introduction to the clinical and pathologic data about sacral insufficiency fractures. We will use illustrations to explain the nature of this fracture. Static radiographic images and movies will be used to show the reader the details of percutaneous sacroplasty procedure and equipments used. Indications, contraindications, and possible complication of the procedure will be discussed.

RESULTS

Percutaneous sacroplasty is a new but successful technique for pain management and consolidation of sacral insufficiency fractures. The pain relief obtained with this technique is not correlated with the volume of cement injected but rather with adequate filling of the entire fracture cavity. The most critical elements for successful sacroplasty are proper patient selection, correct needle placement, good timing of cement injection, strict fluoroscopic control of injection, and operator's experience.

CONCLUSION

The long-term results of sacroplasty are not known, but the patients who receive this kind of treatment report significant relief of symptoms, and the procedure appears to improve their quality of life dramatically. Early results suggest that sacroplasty may be an alternative therapy for sacral insufficiency fractures that warrants further investigation.

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KEY WORDS: Sacroplasty, sacral insufficiency fractures

Computer Assisted Exhibit 36

Cystic Lesions in Lumbar Spinal Canal

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Cystic lesions within the lumbar spinal canal are seen infrequently. Different pathologic processes can present as cystic lesions within the lumbar spinal canal. A knowledge of such lesions will be helpful in narrowing the differential diagnosis. Extramedullary cysts of the lumbar spinal canal may produce a slowly progressive myelo-radiculopathy, or radiculopathy. CT myelography and MR imaging have improved detection and understanding of these cysts. Currently, MR imaging is the imaging modality of choice for the diagnosis and CT myelography is most helpful in establishing communication of the cyst with the subarachnoid space. In the future, CSF flow-sensitive MR techniques will be available to accurately diagnose the cystic lesions of spinal canal and to determine their communication with the subarachnoid space. Surgical resection of symptomatic lesions usually results in complete cure or significant neurologic improvement. This essay reviews the classification, pathophysiology, clinical presentation, and imaging features of lumbar extramedullary spinal cysts. The significant type include - synovial cysts, ganglion cysts, perineural cyst, cystic primary and secondary neoplasms, neuroenteric cysts, infectious processes, resolving hematoma, intra and extradural meningeal cysts, occult sacral meningocele and imaging mimics of cystic lesions

KEY WORDS: Spinal canal, neoplasms, cysts

Computer Assisted Exhibit 37

Compression Fractures of Adjacent Levels Post Complicated Vertebroplasty: Disk Space Polymethylmethacrylate as a Cause of Vertebral Compression Fracture

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PURPOSE

Studies have shown the occurrence of local leaks of polymethylmethacrylate (PMMA) to be common with vertebroplasty, especially into the intervertebral disk space. In a 1997

study, local complications occurred in 29 of the 40 procedures with intervertebral disk extravasation occurring in 8 of those 29. These leaks were deemed to have no clinical importance (1). We reevaluate this statement by presenting five patients who experienced vertebral compression fractures (VCFs) shortly after undergoing vertebroplasty that resulted in intervertebral disk extravasation. All of these VCFs occurred in the end plate adjacent to the extruded PMMA. The appearance and timing of these fractures lead us to speculate that disk space extravasation may contribute to VCFs at adjacent levels.

MATERIALS & METHODS

A retrospective review of patient records of over 510 vertebroplasties in a 28-month period revealed five patients in whom the investigators suspected that disk space extravasation was associated with adjacent level VCF. The images and clinical history were reviewed in each case, and clinical follow-up performed for each patient for 8-24 months (mean 18 months).

RESULTS

The age range of the patients was 71-97 years with a mean of 79 years. The initial levels of vertebroplasty were T7, T12, L1, L2, and L3. The time to next fracture ranged from 1 day to 79 days with a mean of 25 days. The disk space extravasation that occurred in each case resulted in filling of the disk through at least one half of the disk space toward the normal vertebral body above or below. In three cases the extravasation occurred in the superior disk space and in two cases the inferior. The adjacent fracture involved the end plate of the adjacent level in each instance.

CONCLUSION

Previous papers describe no adverse effects after PMMA extravasation into the intervertebral disk space. In our experience with over 510 vertebroplasties performed, there is no pain associated with this local complication. This paper describes five patients in whom VCFs occurred in the adjacent vertebral body within 2 months of a vertebroplasty complicated by intervertebral disk extravasation of PMMA. We believe these cases indicate that disk space extravasation is a complication with the potential for side effects.

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KEY WORDS: Vertebroplasty, complications, disk space extravasation

Computer Assisted Exhibit 38

Prospective Assessment of Pain and Functional Status after Vertebroplasty for Treatment of Vertebral Compression Fractures

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PURPOSE

Recent literature suggests that percutaneous vertebroplasty, when used in the setting of osteoporotic compression fractures, results in substantial and immediate pain relief, improved functional status, and minimal short-term complications. To date there has been no prospective evaluation of vertebroplasty using a validated instrument. We describe the pain and functional status of 72 patients before and after vertebroplasty, as prospectively reported by patient completion of a validated Vertebral Compression Fracture Pain and Functional Disability Questionnaire.

MATERIALS & METHODS

Patient Population. Following an IRB approved protocol, a series of 161 consecutive patients during the period August 1999 to September 2001 were invited to enroll in the study which consisted of completion of the Vertebral Compression Fracture Pain and Functional Disability Questionnaire. Of 161 consecutive patients, 72 consented to participate in the study and self-completed the Vertebral Compression Fracture Pain and Functional Disability Questionnaire prior to undergoing vertebroplasty. **Statistical Analysis.** Differences in patient self-reported pain and distress before and after vertebroplasty, and between the first and second follow-up intervals, were evaluated by Student's t-tests. Mean scores for each of the 24 ADLs (based on the 1 to 5 scale) were plotted at the baseline and first and second follow-up intervals.

RESULTS

The mean age of the 72 patients was 74 years (± 10 years) 80% were female. Prior to vertebroplasty, 13% of patients could not ambulate at all and 59% could not ambulate more than one block. In addition, 15% of patients used a wheelchair and 7% were bedridden. No patients suffered symptomatic complications. Asymptomatic leakage of PMMA into adjacent soft tissues (veins or the disk spaces) was observed in 9%. On the 0 (no pain) to 10 (pain as bad as it could be) visual analog pain scale patients reported significantly more pain, on average, before undergoing vertebroplasty than at the first follow-up interval (mean 5.8 vs 3.5, $P < 0.001$). Importantly, the substantial reduction in reported pain following vertebroplasty persisted at the second follow-up on both the visual analog and adjectival pain scales. The ability to perform each of the 24 ADLs without pain was substantially greater at both follow-up intervals compared to before undergoing vertebroplasty. Among the 24 ADLs, between 25% to 69% of patients reported a mean improvement (between the baseline and first follow-up interval) of at least one level on the 5-point ADL scale, and between 14% to 55% reported a mean improvement of at least two levels. The reported worsening of ability to perform ADLs between the first and second follow-up intervals ranged from 0% to

36% of patients for at least one level, and from 0% to 14% of patients for at least two levels. Thus, the majority of the substantial improvement in reported functional status following vertebroplasty was sustained at the second follow-up interval.

CONCLUSION

In this prospective nonrandomized trial, PV resulted in substantial, lasting reduction in pain and improvement in ability to perform ADLs.

KEY WORDS: Vertebroplasty, pain, vertebral compression fractures

Computer Assisted Exhibit 39

The Keck School of Medicine of the University of Southern California Comprehensive Spinal Imaging Course

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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, videofluoroscopy, CT and MR imaging. The course is designed to present the spine in its totality, as an entity with three functions, supporting the head and body, allowing mobility, and protecting the spinal cord. The purpose of this computer exhibit is to demonstrate several segments of the interactive CD-based course in spine radiology. It is intended to weave a total picture of spinal anatomy, biomechanics, and physiology. It is designed to teach basic concepts rather than the details of rare entities. Symptom correlation with observed abnormalities is stressed.

MATERIALS & METHODS

Several PowerPoint lectures on various aspects of cervical and lumbar spine anatomy and physiology will be read from CDs. Imbedded in these presentations is a combination of text, voice, and video used to challenge the trainee's powers of observation and deduction. There are many quiz questions about the images pervading the lectures.

RESULTS

A portion of the University of Southern California radiology course will teach the radiographic anatomy and physiology in a most unusual way.

CONCLUSION

The course in its entirety provides a novel approach for learning spinal imaging.

KEY WORDS: Spine, imaging, course

Computer Assisted Exhibit 40

Comprehensive Diagnostic Evaluation of Cervical Spine Trauma

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PURPOSE

This scientific exhibit reviews the current state-of-the-arts for diagnostic imaging of cervical spine trauma using multiple imaging modalities. The mechanisms of injury, typical patterns of fracture, common complications of cervical spine fractures are reviewed. The clinical features of trauma patients that dictate which should be imaged and what imaging modality should be used are discussed. An algorithmic approach is presented for guiding the diagnostic evaluation. Diagnostic pitfalls are presented. The results of this study are presented in an interactive multimedia format (audio, video).

MATERIALS & METHODS

The diagnostic images (conventional radiographs, CT, 3D CT, MR imaging, MR angiography, CT angiography, flexion-extension radiographs) of 174 consecutive patients with cervical spine fractures were reviewed retrospectively and the diagnostic studies analyzed.

RESULTS

A wide array of probable fracture mechanisms was identified (hyperflexion, hyperextension, lateral hyperflexion, axial loading, shearing, complex). The major complications that were observed included (cord contusion-transection, vertebral artery injury, intraspinal hematoma, spinal cord hematoma, dural tear, nerve root and brachial plexus avulsion, traumatic disk herniation, ligamentous injury, cervical dislocation).

CONCLUSION

Multiple imaging modalities often are required to identify and classify cervical fractures and to assess for the myriad of complications resulting from these fractures. The use of MR imaging and occasionally flexion-extension radiographs are essential for assessment of ligamentous injury that may be missed on CT imaging. Multislice thin-section CT is of paramount importance for identification of fractures and 3D CT may be helpful for surgical planning. MR angiography and CT angiography are essential for assessing for potential vascular injury.

KEY WORDS: Trauma, cervical spine, imaging

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Notes

**Wednesday Afternoon
1:00 PM - 2:30 PM
Ballroom 6 A**

**(43A) NeuroNews:
Developing Research
and Emerging Trends**

Moderator: Robert Koenigsberg, MD

Paper 43A-1 Starting at 1:00 PM, Ending at 1:09 PM

**The Use of Radiofrequency for the Palliative
Treatment of Sacral Chordomas**

Nassar, A. N. • Nohra, C. • Khoneisser, A.

Lebanese Hospital, Geitawi
Beirut, LEBANON

Complete radical surgical resection of sacral chordomas is difficult to achieve in most of the cases due to the highly associated morbidity and the presence of adjacent important structures including the sciatic nerves. In addition, chordomas are known to be radio-resistant. Only 8% of patients show a disease-free survival rate. In spite of almost a 100% recurrence rate, surgery is still used aimed at radical resection. However, in the presence of aggressive recurrences, palliative treatment should be proposed. A single case report is published in the literature in the American Journal of Radiology in November 2002 describing the use of radiofrequency in the treatment of sacral chordoma. We present two cases of sacral chordomas that underwent repeated surgeries and radiotherapy to no avail. These patients underwent radiofrequency for palliative control of mass effect and an attempt at pain relief, with immediate and excellent response. Patients were pain free in the 24 hours following the procedure. Total procedure time of around 1 hour was average. No complications occurred. The advantages offered by the radiofrequency method which consist of short hospital stay (average 1 day), low cost, low morbidity and very low complication rate (none in our cases and in the reported case) when compared to palliative surgery, would indicate its use as a primary palliative method for the control of pain and mass effect. Although we have very short follow-up periods (14 months), the rapid and dramatic response to therapy in our patients' conditions supports the proposed suggestion. However, the reports in the literature are still few and

multicentral studies for a larger number of patients are still required. The advantages offered are: Short treatment time. Low treatment cost. Short inpatient stay. Thus, cut healthcare costs.

Key Words: Radiofrequency, ablation, chordomas

Paper 43A-2 Starting at 1:09 PM, Ending at 1:18 PM

Ferumoxtran-10 for Intraoperative Navigation

Neuwelt, E. A. • Hunt, M.

Oregon Health & Science University
Portland, OR

Purpose

Ferumoxtran is a paramagnetic, dextran-coated iron oxide particle that can be used as a MR contrast agent. Needing only to be given once, 24 hours prior to surgery, ferumoxtran can be used for stereotactic guidance as well as intraoperative MR imaging, and remains long enough for postoperative MR imaging. Intraoperative MR imaging has advantages over conventional framed and frameless techniques. However, intraoperative MR imaging does have some drawbacks, especially related to interpretation of gadolinium-enhanced intraoperative imaging resulting from surgically induced blood-brain barrier injury, vascular changes and hemorrhage. Ultra-small paramagnetic iron (USPIO) particles like ferumoxtran-10 have a long plasma half-life and are trapped by reactive cells within the tumor. These trapped particles provide a method to demonstrate enhancing lesions without the artifact of repeat gadolinium administration in the face of blood-brain barrier and vascular injury, especially for intraoperative MR imaging and postoperative MR imaging.

Materials & Methods

We present five patients who underwent surgery using conventional frameless stereotactic guidance as well as with intraoperative MR imaging with ferumoxtran-10 and a review of the literature.

Results

Ultra-small paramagnetic iron particles represent a method to demonstrate enhancing intrinsic brain tumors without the drawbacks of intraoperative gadolinium enhancement. These lesions appear even on low-field strength intraoperative MR imaging. Ferumoxtran-10, administered preoperatively, provides a stable imaging marker, even after surgical manipulation of the brain.

Conclusion

Fermumoxtran-10 provides a way to lessen artifactual enhancement during intraoperative MR imaging related to the administration of gadolinium, and may be beneficial in postoperative MR imaging as well.

Key Words: Image, guided, surgery

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of Combidex (ferumoxtran-10) made by Advanced Magnetix, Inc. for use as an imaging agent.

Paper 43A-3 Starting at 1:18 PM, Ending at 1:27 PM

Very High-Resolution Contrast-Enhanced MR Angiography of the Carotid Arteries Using Ferumoxytol in Humans

Meyer, J. R. • Mai, V. M. • Li, W. • Pierchala, L. • Tutton, S. • Ankenbrandt, W. • Edelman, R.

Northwestern University Medical School
Evanston, IL

Purpose

To study the feasibility of very high-resolution contrast-enhanced 3D MR angiography (CE-3DMRA) of the extracranial CA using ferumoxytol.

Materials & Methods

Ferumoxytol (Advanced Magnetix Inc., Boston, MA), an iron oxide blood-pool contrast agent with a plasma half-life of 14 hours, was used to obtain very high-resolution MRA of the extracranial CA. Studies were performed with IRB approval and informed, written consent. A dosage of 4 mg/kg diluted to 7.5 mg/ml was infused at 2 cc/sec. All studies were performed on a 1.5 T system (GE Medical Systems, Milwaukee, WI) equipped with TwinSpeed gradients and a 4-channel neurovascular coil. A series of 8 subjects (3 volunteers and 5 patients, 4 male/4 female, average age of 56.6 years) were studied. First-pass imaging was performed using either a fluoroscopically triggered 3D MRA or a temporally resolved TRICKS acquisition. This was followed by an optimized very high-resolution 3DMRA sequence using the following parameters: TR/TE of 4.9 msec/1.4 msec, sampling BW of 83 kHz, FOV 26 cm, matrix size of 512 x 512, 1 NEX, and interpolated partition thickness of 0.8 mm. The in-plane spatial resolution was 0.5 x 0.5 mm. An axial 3D volume of 128 partitions covering the circle of Willis through the extracranial carotid bifurcation was acquired in approximately 5.5 min. In addition, a 3DMRA with lower in-plane resolution (256 x 256) as well as a precontrast axial 2D TOF MRA were acquired. Multiplanar and maximum intensity reconstructions were performed. Image quality was assessed on a 5-point scale; SNR and CNR were measured in the source images.

Results

No adverse events occurred. Very high-resolution MR angiograms showed improved delineation of the CA compared with first-pass images, steady-state images acquired at 256 x 256, and 2D TOF MRA. Oblique multiplanar reconstructions eliminated venous overlap and provided excellent delineation of the carotid bifurcations.

Conclusion

Current first-pass methods for CE-3DMRA of the CA suffer from limited spatial resolution. This problem can be overcome using nearly isotropic, very high-resolution MRA with ferumoxytol. The method has the potential to improve the accuracy and precision of measurements of carotid artery disease compared with current MRA methods.

Key Words: MRA, contrast, carotid

Paper 43A-4 Starting at 1:27 PM, Ending at 1:36 PM

Superiority of Propeller FSE FLAIR to Conventional FSE FLAIR for 8-Channel Phased-Array Brain Imaging in Clinical Practice

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Purpose

To evaluate the performance of propeller FSE FLAIR with respect to FSE FLAIR using 8-channel phased-array coils in the evaluation of patients presenting for brain imaging in clinical practice.

Materials & Methods

Consecutive patients referred for MR imaging with symptoms suggesting neurological disease were evaluated with fast FSE FLAIR acquisitions performed with conventional and precommercial prototype propeller reconstruction techniques using commercially available 8-channel brain or neurovascular coils. Studies were compared with respect to ghosting and motion artifact by two blinded reviewers. A quantitative comparison of SNR was also performed. PROPELLER MR imaging (1) uses a novel approach to measure spatial frequencies. After each excitation (each shot), PROPELLER measures spatial frequencies along a strip, or blade, which goes through the central region of k-space. This usually is done by using all the echoes from a single, central shot of a multishot FSE readout. For each subsequent shot, the blade is rotated, until all the necessary spatial frequencies to form a complete image are measured. As seen the data from each blade (each TR) can be used to form an image which contains all of the low frequency information inside of that

circle plus limited high frequency information. The data from these blades can be combined in k-space to form a complete image. This resampling of the low spatial frequencies every shot is a key element of PROPELLER. Since the image formed from these data should look identical, one can look for inconsistencies from shot to shot, and correct the data accordingly. Reconstructions can be developed which can thus correct for in-plane motion (translation and rotation), correct for phase inconsistencies such as those introduced with diffusion lobes, and reject uncorrelated data (such as bulk through-plane motion).

Results

Studies obtained with propeller reconstructions were superior to those obtained with conventional reconstruction techniques with respect to ghosting, motion artifact, and SNR.

Conclusion

Propeller FSE techniques are superior to conventional techniques offering superior SNR as well as resistance to motion artifacts and ghosting. Propeller FSE will likely replace conventional acquisitions for routine use in the clinical setting.

References

1. Pipe JG. **Motion Correction with PROPELLER MRI: Application to Head Motion and Free-Breathing Cardiac Imaging.** *Magn Reson Med* 1999;42:963-969

Key Words: PROPELLER, FLAIR, 8 channel

The authors of this work have indicated the following affiliations/disclosures: GE Medical Systems: Speaker, Employees

Paper 43A-5 Starting at 1:36 PM, Ending at 1:45 PM

Neuroform Stent-Assisted Coiling in the Management of a Ruptured Pericallosal-Callosomarginal Aneurysm

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Purpose

There are few reports describing the successful endovascular treatment of aneurysms arising at the bifurcation of the pericallosal and callosomarginal arteries. We present the case of a ruptured bilobed pericallosal aneurysm successfully treated with coil embolization through a Neuroform stent (Boston Scientific/Target, Fremont, CA.). We believe this is the first such case reported in the literature.

Materials & Methods

A 48-year-old male presented with subarachnoid hemorrhage following rupture of an aneurysm arising at the bifurcation of the pericallosal and callosomarginal

arteries, Hunt and Hess Grade V. Past medical history is significant for malignant hypertension and previous surgical clipping of same aneurysm 2 years earlier. The patient was referred for angiography post-imaging studies and ventriculostomy.

Results

Diagnostic angiography revealed a persistent left pericallosal-callosomarginal aneurysm with an adjacent surgical clip. An initial attempt was performed to embolize the aneurysm with a detachable coil. This was unsuccessful due to the wide neck. A 4 x 15 Neuroform stent then was deployed uneventfully across the aneurysm neck followed by successful coil embolization with six detachable coils. The bilobed aneurysm was subsequently completely packed, without angiographic residua.

Conclusion

This case demonstrates the successful use of the Neuroform stent to assist in wide-neck aneurysm coiling of a pericallosal-callosomarginal aneurysm. It is presented with a brief review of the technique and literature.

References

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Key Words: Neuroform, pericallosal, coiling

Paper 43A-6 Starting at 1:45 PM, Ending at 1:54 PM

Early Clinical Trial Experience with a New Self-Expanding Stent System (Wingspan™) in Treating Intracranial Vertebral-Basilar Atherosclerotic Disease

Chang, F.^{1,2} • Teng, M.^{2,2} • Bose, A.³ • Luo, C.^{4,2} • Lin, J.^{2,4}

¹Taipei Veterans General Hospital, Taipei, TAIWAN REPUBLIC OF CHINA, ²National Yang Ming University, School of Medicine, Taipei, TAIWAN REPUBLIC OF CHINA, ³Neurointerventional Service, New York University School of Medicine, New York, NY, ⁴Department of Radiology, Taipei Veterans General Hospital, Taipei, TAIWAN REPUBLIC OF CHINA

Purpose

Medically refractory stenosis of intracranial arteries carries a high risk of stroke. Angioplasty and stenting of intracranial arteries by balloon expandable stents have been reported. However, these balloon mounted stents often have difficulty in accessing the tortuous intracranial

circulation and can cause vascular injury during endovascular navigation and during high pressure balloon inflation for stent deployment. These risks are accentuated in the fragile vasculature of the vertebro-basilar system. We report our initial experience using the Boston Scientific self-expanding Wingspan™ Stent System

Materials & Methods

Case 1. A 76-year-old male suffered recurrent right hemiparesis despite antiplatelet and anticoagulant therapy. Small pontine and occipital infarcts were evident on MR imaging. Angiography demonstrated a segmental stenosis compromising 75% of the vascular lumen in the mid-basilar artery. Angioplasty and stenting of the basilar artery stenosis was performed over a 0.014" Choice PT micro-guidewire. The diameter of the prestenotic basilar artery was measured to be 3 mm, and predilatation of the stenotic segment was performed with a 2.5 mm Gateway microballoon at 6 atm. The stenosis was reduced to 60% after a single inflation. Subsequently, a 3 mm x 15 mm self-expanding nitinol stent (Wingspan™) was deployed over the stenotic segment. Postprocedure control angiography demonstrated a residual stenosis of 36%. The patient was discharged home with no neurologic symptoms. Case 2. A 73-year-old male suffered transient ischemic attacks and recurrent dizziness in recent months. Angiography showed 80% stenosis in the left distal vertebral artery measuring 4 mm in prestenotic luminal diameter. Over a 0.014" Transcend microguidewire the stenosis was predilated with a 3.5 mm Gateway microballoon to 6 atm which resulted in a residual stenosis of 42%. Subsequently, a 4 mm x 20 mm Wingspan™ stent was deployed. Control angiography revealed a residual stenosis of 25%. The patient was discharged home free of neurologic symptoms.

Results

Both patients showed successful angioplasty and stenting of intracranial vertebro-basilar stenosis without complication. The residual stenosis after angioplasty was further reduced acutely by the positive remodeling force of the self-expanding Wingspan™ stent.

Conclusion

In the treatment of intracranial vertebro-basilar stenosis, the Wingspan™ self-expanding stent and microcatheter-based delivery system demonstrated good trackability and could navigate tortuous intracranial vasculature without difficulty. Under-sizing the angioplasty balloon with respect to the normal diameter of the parent vessel during predilatation of the stenotic lesion avoided unnecessary vascular injury to the parent vessel lumen such as dissection or rupture. The positive remodeling force of a self-expanding nitinol stent can further dilate a residual stenosis after angioplasty. Early experience suggests that angioplasty and stenting of intracranial arterial stenosis with the Wingspan™ self-expanding stent may be a safe and feasible option for stroke prevention. Enrollment and long-term follow-up is ongoing.

Key Words: Stent, basivertebral stenosis

A New Generation of Self-Expanding Nitinol Intracranial Stent System in Symptomatic, High Grade Intracranial Atherosclerotic Stenosis: Strategy for Predilation of the Lesions and Stent Deployment to Minimize Vessel Trauma

Hartmann, M.¹ · Ringleb, P. · Bose, A.¹ · Berez, A.² · Sit, S.³

¹University of Heidelberg Medical School, Heidelberg, GERMANY, ²New York University School of Medicine, New York, NY, ³Boston Scientific Neurovascular, San Leandro, CA

The Wingspan™ (WST) is a new generation of self-expanding stents specifically designed for the treatment of intracranial (IC) atherosclerotic disease. It is made of ultra-thin nitinol, low profile and highly flexible. The WST stent system consisted of a 3.5 F delivery catheter with inner through-lumen with the stent preloaded for deployment. The system also contained a Gateway™ PTA balloon catheter with the intended use of predilating the lesions, followed by WST self-deployment with sufficient radial force to remodel severely stenosed vessels without the need for postdilation. To minimize trauma, the size of the PTA balloon is under-sized to 80% of parent vessel diameter with slow inflation to no more than nominal pressure. Described herein are initial experiences with the WST system in patients with severe symptomatic stenosis who have failed antithrombotic therapy. Major entry criteria are recurrent stroke attributed to target lesions 2 - 4.5 mm in diameter with stenosis > 50% and < 14 mm in length, failed medical therapy, and a Modified Rankin score (MRS) of < 3. Three patients with symptomatic atherosclerotic stenosis, mean age 69 years, with vessel sizes ranging from 2.0-3.6 mm, lesion lengths from 1.9 to 6.8 mm in the petrous ICA, carotid-T and M1 were treated. The degree of stenosis according to the WASID method was reduced from a median of 89% to 35% after balloon angioplasty and to 21% after WST placement. Postdilation was not required. The trackability of the WST delivery catheter through tortuous vasculature was very good and there was more than sufficient wall apposition to remodel all lesions without the need for postdilation. All 3 patients successfully completed the PTA and stenting procedures and discharged neurologically intact. No complication, vessel dissection/rupture, or thromboembolic events occurred. No stroke or death occurred at 30-day follow-up; the status of all patients was stable with relief of symptoms and no restenosis was revealed by transcranial Doppler at 30 days. These results indicate that the Boston Scientific self-expanding Wingspan™ Stent System with Gateway™ PTA Balloon Catheter may be a safe treatment of atherosclerotic intracranial lesions. Undersizing of PTA balloon and self-expansion of WST may minimize trauma to the parent vessel while providing for good wall apposition. Enrollment and long-term follow-up are ongoing.

Key Words: Stent, intracranial, stenosis

The authors of this work have indicated that they will be discussing/presenting an unapproved or investigative use of Wingspan™ made by Boston Scientific Neurovascular for use as self-expanding stents specifically designed for the treatment of intracranial (IC) atherosclerotic disease.

The authors of this work have indicated the following affiliations/disclosures: Boston Scientific: Paid Consultant, Employees

Paper 43A-8 Starting at 2:03 PM, Ending at 2:12 PM

In Vitro Labelling of Mouse Neural Stem Cells with Superparamagnetic Iron Oxide Particles and Initial In Vivo Tracking Study after Intravenous Injection in Mice Affected by Experimental Autoimmune Encephalomyelitis

Politi, L. S.¹ · Pluchino, S.¹ · Bacigaluppi, M.¹ · Cadioli, M.^{1,2} · Anzalone, N.¹ · Falini, A.¹ · Martino, G.¹ · Scotti, G.¹

¹Ospedale San Raffaele, Milano, ITALY, ²Philips Medical Systems, Milan, ITALY

Purpose

We have recently shown that intravenously injected adult undifferentiated mouse neural stem cells (aNSC) promote multifocal remyelination and functional recovery in mice affected by a chronic form of experimental autoimmune encephalomyelitis (EAE). Here we performed a feasibility study of labelling aNSC with different superparamagnetic iron oxide particles (SPIO) with or without poly-L-lysine (PLL), a transfection agent, and evaluated the possibility of tracking them in vivo by serial MR scans along the posttransplantation follow-up.

Materials & Methods

aNSC were labelled with increasing concentrations of Fe (0.01, 0.02, 0.06, 0.1, 0.2, 0.8 mg) of two different SPIO contrast media (Endorem, Guebert; Resovist, Schering) by incubation with or without PLL for 72 hours. Cell viability, proliferation and differentiation were tested at 8 days. Iron uptake and dismission also were assessed by microscopy. Agarose phantoms containing dispersed unlabelled and labelled cells or free SPIO were prepared and signal change with routinely used sequences and T2 relaxometry were measured at 1.5 with a 23 mm surface coil. Six C57BL/6 mice were immunized with MOG35-55 in CFA and - at the onset of clinical signs suggestive of CNS demyelination - underwent intravenous injection of 10⁶ aNSC labeled in vitro for 72 hours with 0.1 mg/ml of SPIO (Endorem, Guebert) plus PLL. Longitudinal MR scans (at day 1, 5 and 10 from the transplantation) were performed. Neuropathological analysis (Prussian blue) of the CNS of transplanted EAE mice also was performed at sacrifice.

Results

In vitro uptake of all SPIOs was much higher when aNSCs were incubated with both PLL and iron nanoparticles. Cell viability, proliferation and differentiation were not affected up to a concentration of 0.2 mg of iron, and slight cell toxicity was found when cells were incubated with 0.8 mg/ml Fe. The decrease of MR imaging signal was much higher when PLL was used. Of the two SPIO used, Endorem showed the highest signal decrease. Once intravenously injected, magnetically labelled aNSCs were identified as small hypointense spots within the white matter lesions as early as 1 day after the iv injection but progressively faded out at either 5 or 10 days posttransplantation. Neuropathology confirmed the presence of iron-labeled transplanted cells within areas of demyelination and axonal damage.

Conclusion

aNSCs can be successfully labelled in vitro with SPIOs, without compromising cell viability and proliferation. All MR imaging parameters are significantly affected by the presence of these SPIO particles within cell bodies and increase linearly with the iron cell concentration. Early temporal and spatial migration of intravenously administered SPIO-labelled aNSC can be monitored by MR imaging. SPIOs tracers may represent a helpful tool for tracking transplanted neural stem cells in either preclinical or clinical studies in both animal models and humans.

Key Words: Neural stem cells, SPIO labelling, demyelinating disorders

The authors of this work have indicated the following affiliations/disclosures: Philips Medical Systems, Employee

Paper 43A-9 Starting at 2:12 PM, Ending at 2:21 PM

Real-Time MR Imaging-Guided Neurovascular Intervention

Pile-Spellman, J.¹ · Feng, L.¹ · Lin, E.¹ · Gupta, G.¹ · Dashnaw, S.¹ · Zhang, H.¹ · Oklu, R.¹ · Baytton, M.¹ · Dumoulin, C.²

¹Columbia University, New York, NY, ²General Electric, Schenectady, NY.

Purpose

Compared to conventional fluoroscopy, real-time MR imaging guidance offers many advantages for diagnostic and interventional neurovascular procedures. Continuous intraprocedural assessment of tissue viability and brain function with diffusion-weighted imaging, perfusion-weighted imaging, and functional MR imaging provides new dimensions for the treatment of cerebrovascular diseases, particularly ischemic stroke. Visualization of neurovascular anatomy is available with multiplanar MRA

images and 3D reconstructions. MR imaging-guided endovascular procedures are safer to patients and operators due to the lack of ionizing radiation. Furthermore, gadolinium-based contrast agents exhibit lower nephrotoxicity and allergic potential than iodinated contrast agents. We performed a pilot animal study to assess feasibility of performing interventional neurovascular procedures under real-time MR imaging guidance.

Materials & Methods

After obtaining percutaneous vascular access to the femoral artery on the MR table, transfemoral catheterization of the carotid arteries was performed in 10 pigs using active MR-tracking catheters and guidewires. Intraarterial (IA) contrast-enhanced MRA confirmed catheter position and evaluated the distal vascular anatomy. Carotid stenting was performed in five animals. The carotid and subclavian arteries were occluded with balloons to create stroke models in five animals and intraarterial thrombolysis was carried out in two animals. Necropsy was performed on all animals to assess the intervention and presence of unintended vascular injury.

Results

The carotid arteries were catheterized minutes after obtaining vascular road maps. Ten nitinol stents were successfully placed into the bilateral carotid arteries in all five animals (Figure 1). The stent positions were confirmed by necropsy with no unintended vascular injury. In separate experiments, all target vessels were occluded successfully with balloons (Figure 2). After the carotid artery branches were occluded intentionally with blood clots in two animals, we infused IA rtPA, which resulted in recannulization of these vessels (Figure 3).

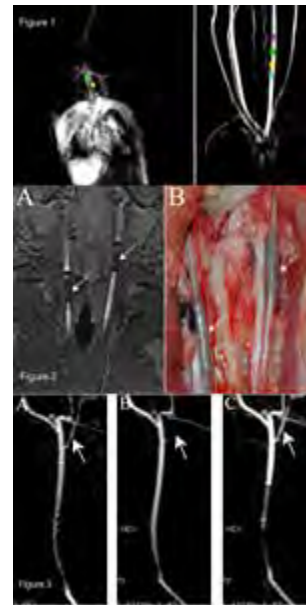
Conclusion

Carotid stenting, embolization, and thrombolytic procedures were performed successfully in a swine model using active MR-tracking, suggesting neurovascular intervention may be feasible under real-time MR imaging guidance.

Fig. 1. Active-tracking catheterization. Catheterization of brachiocephalic artery with active-tracking devices. (A, aorta; BCA, brachiocephalic artery; LSCA: left subclavian artery; CCA: common carotid artery).
b. Catheterization of the common carotid arteries with active-tracking devices.

Fig. 2. Stents in bilateral carotid arteries.
a. A coronal FSPGR image with T1 weighting demonstrates hyperintense blood in the carotid lumens. The stents are identified by the susceptibility artifacts of nitinol. The inferior margin of the left stent is intentionally matched with the superior edge of the right stent.
b. Necropsy reveals the stents in the same positions as shown on MRI. Both common carotid arteries have shiny adventitia without evidence of perforation or mural hematoma formation.

Fig. 3 a. IA contrast-enhanced MRA of left carotid artery.
b. Occlusion of ascending pharyngeal artery.
c . Recanalization after thrombolysis.



Key Words: Real-time MR imaging-guidance, interventional neuroradiology

The authors of this work have indicated the following affiliations/disclosures: General Electric, Employee

Paper 43A-10 Starting at 2:21 PM, Ending at 2:30 PM

Three-Dimensional and Dynamic Sequences in Fetal MR Imaging

Prayer, D. • Brugger, P. C. • Kasprian, G. • Mittermayer, C. • Krampl, E. • Herold, C.

Medical University Vienna
Vienna, AUSTRIA.

Purpose

To demonstrate the ability of 3D and dynamic sequences to add information to fetal CNS-MR studies.

Material & Methods

In 15 consecutive fetal MR images, done because of suspect CNS/extra CNS abnormalities, between the 19th and 32nd gestational week (GW), SSFSE - (20-40 mm slab), and dynamic TFE sequences (8-50 mm thickness, 4 frames/second) were added to the routine fetal-MR imaging protocol [including T2, T1, FLAIR, diffusion-weighted imaging, and steady state free precession sequences (1)]. Indications consisted of twin-to-twin transfusion syndrome (3), ventricular asymmetry (1), suspect choroid plexus cyst (1), intrauterine growth restriction (2), Chiari II malformation (1), cardiac tumor (1), facial cleft (2), diaphragmatic hernia (3), dwarfism (1) and polyhydramnios (2). On 3D images gyration, body

surface, shape of extremities, thickness of soft-tissue, and configuration/course of the umbilical cord were evaluated. Dynamic sequences were screened for the proof of normal general movements (2), and in case of spinal pathology especially for all qualities of leg movements, hand movements, and swallowing.

Results

Three-dimensional sequences showed normal conditions in 13/18 cases, pathology detected/confirmed by 3D imaging consisted of: abnormalities of face/skull relation (3), extremities (2), and soft-tissue thickness (2). In 12/18 fetuses general movements/leg-movements were observed at least once during the examination time (30-40 minutes), hand movements in 8/18, and swallowing in 6/10 in whom this movement was especially looked for.

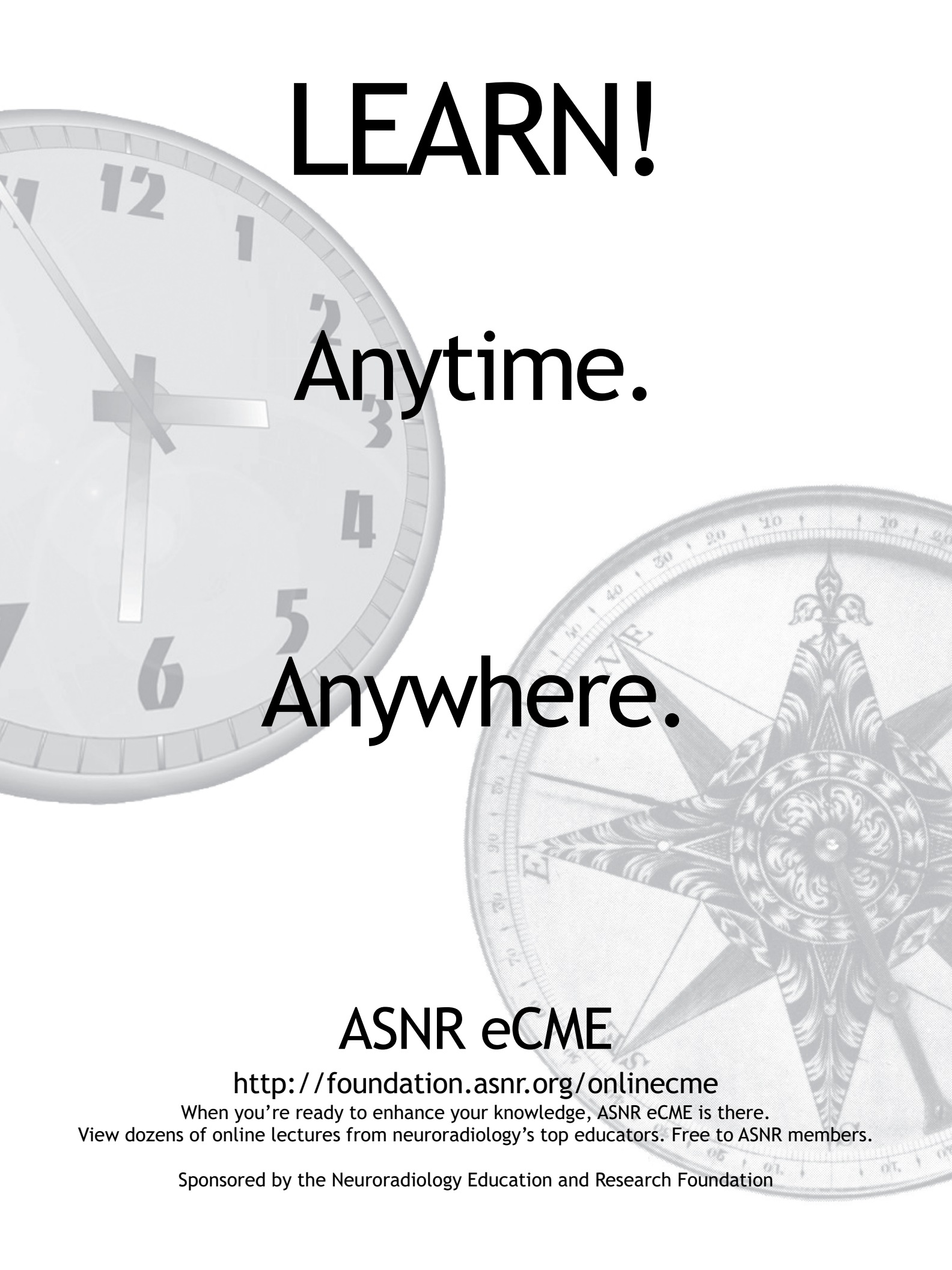
Conclusion

Three-dimensional and especially dynamic fetal imaging add functional information that allows a more accurate estimation of pathologic conditions than the use of routine sequences only. In addition, this sort of “clinical” information introduces a new dimension to fetal MR imaging.

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Key Words: Fetal magnetic resonance, dynamic imaging, fetal movements



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