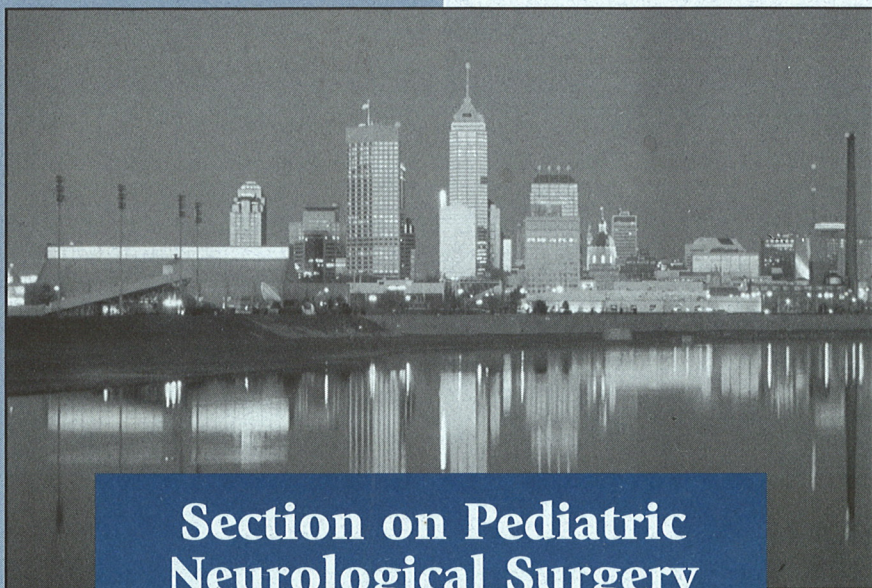


**The American Association of
Neurological Surgeons
AND
Congress of Neurological Surgeons**



**Section on Pediatric
Neurological Surgery**

**27th Annual Meeting
December 1-4, 1998**

**The Westin Indianapolis
Indianapolis, Indiana**

Jointly sponsored by The American Association of Neurological Surgeons

**Section on
Pediatric Neurological Surgery
of
The American Association of
Neurological Surgeons
and
Congress of Neurological Surgeons**



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This activity has been planned and implemented in accordance with the Essentials and Standards of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of The American Association of Neurological Surgeons and the AANS/CNS Section on Pediatric Neurological Surgery. The ACCME accredits The American Association of Neurological Surgeons to sponsor continuing medical education for physicians.

The American Association of Neurological Surgeons designates this educational activity for 21.5 credit hours (with attendance of Breakfast Seminars) in category 1 toward the AMA Physician's Recognition Award with an additional 1.5 hours available for those attending the Lunch Seminar for Residents and Fellows and an additional 5 hours available for those attending the Nurse Seminar. Each physician should claim only those hours that he/she actually spent in the educational event.

Program Summary

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Raimondi Lecturers

1978	E. Bruce Hendrick	1989	Martin Eichelberger
1979	Paul C. Bucy	1990	George R. Leopold
1980	Floyd Gilles	1991	Judah Folkman
1981	Panel Discussion	1992	Olof Flodmark
1982	Panel Discussion	1993	Maurice Albin
1983	Derek Harwood-Nash	1994	Blaise F.D. Bourgeois
1984	Anthony E. Gallo, Jr.	1995	Robert H. Pudenz
1985	Frank Nulsen	1996	Samuel S. Flint
1986	William F. Meacham	1997	M. Michael Cohen, Jr.
1987	Dale Johnson	1998	Robert A. Zimmerman
1988	Joseph J. Volpe		

Kenneth Shulman Award Recipients

1983	Kim Manwaring: Neonatal Post-Hemorrhagic Ventriculomegaly: Management with Pulsed Lumbar Cisternostomy
1984	Arno Fried: A Laboratory Model of Shunt-Dependent Hydrocephalus
1985	Anne-Christine Duhaime: The Shaken Baby Syndrome
1986	Robert E. Breeze: CSF Formation in Acute Ventriculitis
1987	Marc R. DelBigio: Shunt-Induced Reversal of Periventricular Pathology in Experimental Hydrocephalus
1988	Scott Falci: Rear Seat-Lap Belts. Are They Really "Safe" for Children?
1989	James M. Herman: Tethered Cord as a Cause of Scoliosis in Children with a Myelomeningocele
1990	Christopher D. Heffner: Basilar Pons Attracts Its Cortical Innervation by Chemotropic Induction of Collateral Branch Formation
1991	P. David Adelson: Reorganization of the Cortical-Tectal Pathway Following Neonatal Cerebral Hemispherectomy in Cats
1992	David Frim: Effects of Biologically Delivered Neurotrophins in Animal Models of Neural Degeneration
1993	Monica C. Wehby: Metabolic Demonstration of Retained CNS Function in the Rabbit Model of Infantile Hydrocephalus
1994	Ellen Shaver: Experimental Acute Subdural Hematoma in Infant Piglets
1995	Seyed M. Emadian: Correlation of Chromosome 17p Loss with Clinical Outcome in Patients with Primitive Neuroectodermal Tumors
1996	John Park, MD, PhD: Platelet Derived Growth Factor Induces Differentiation of Neuroepithelial Stem Cells into Neurons
1997	Michael J. Drewek, MD: Quantitative Analysis of the Toxicity of Human Amniotic Fluid to Rat Fetal Spinal Cord Cultures

Hydrocephalus Association Award Recipients

- 1989 Eric Altschuler: Management of Persistent Ventriculomegaly Due To Altered Brain Compliance
- 1990 S. D. Michowiz: High Energy Phosphate Metabolism in Neonatal Hydrocephalus
- 1991 Neshor G. Asner: Venous Sinus Occlusion and Ventriculomegaly in Craniectomized Rabbits
- 1992 Marcia DaSilva: Reversal of High Energy Phosphate Metabolism Changes in Experimental Hydrocephalus After CSF Shunting
- 1993 Charles Bondurant: The Epidemiology of Cerebrospinal Fluid Shunting
- 1994 Monica C. Wehby-Grant: The Rabbit Model for Infantile Hydrocephalus: Regional Differences in the Cortical Metabolic Response to Hydrocephalus and Shunting
- 1995 Richard J. Fox: Cerebrospinal Fluid Absorptive Site of the Parasagittal Dura: A Cadaveric Study
- 1996 Martha J. Johnson: Reactive Astrocytosis in a New Model of Obstructive Hydrocephalus
- 1997 No award given.

Pediatric Section Chairmen

1972-73	Robert L. McLaurin	1983-85	Harold J. Hoffman
1973-74	M. Peter Sayers	1985-87	William R. Cheek
1974-75	Frank Anderson	1987-89	David G. McLone
1975-76	Kenneth Shulman	1989-91	Donald H. Reigel
1976-77	E. Bruce Hendrick	1991-93	Arthur Marlin
1977-78	Frank Nulsen	1993-95	Arthur Marlin
1978-79	Luis Schut	1995-97	Harold L. Reigate
1979-81	Fred J. Epstein	1997-99	Marion L. Walker
1981-83	Joan L. Venes		

Annual Winter Meeting Sites

1972	Cincinnati	1983	Toronto	1994	St. Louis
1973	Columbus	1984	Salt Lake City	1995	Pasadena
1974	Los Angeles	1985	Houston	1996	Charleston
1975	Philadelphia	1986	Pittsburgh	1997	New Orleans
1976	Toronto	1987	Chicago	1998	Indianapolis
1977	Cleveland	1988	Scottsdale	1999	Atlanta
1978	Philadelphia	1989	Washington, D.C.	2000	San Diego
1979	New York	1990	San Diego & Pebble Beach	2001	New York
1980	New York	1991	Boston	2002	Phoenix
1981	Dallas	1992	Vancouver, BC		
1982	San Francisco	1993	San Antonio		

Exhibitor Listing

The AANS/CNS Section on Pediatric Neurological Surgery gratefully recognizes the support of the following exhibitors:

- | | |
|--|--|
| Acra-Cut, Inc. Booth 17
989 Main Street
Acton, MA 01720
(978)263-2210 | Hydrocephalus Association Booth 9
870 Market Street, Suite 955
San Francisco, CA 94102
(415)732-7040 |
| Anspach Companies Booth 33
4500 Riverside Drive
Palm Beach Gardens, FL 33410
(561)627-1080 | KLS-Martin, L.P. Booth 36
P.O. Box 50249
Jacksonville, FL 32250
(904)641-7746 |
| Bel-Med, Inc. Booth 21
P.O. Box 888321
Atlanta, GA 30356-0321
(414)539-3564 | Komet Medical Booth 31
800 King George Blvd.
Savannah, GA 31419
(800)732-1934 |
| Bio-Vascular, Inc. Booth 34
2575 University Ave.
St. Paul, MN 55114
(651)603-3716 | Leica Microsystems, Inc. Booth 8
110 Commerce Drive
Allendale, NJ 07401
(800)526-0355 |
| BrainLAB Booth 19
3100 Hansen Way
Palo Alto, CA 94304
(650)494-7240 | Linvatec/Hall Surgical Booth 35
11311 Concept Blvd.
Largo, FL 33773
(813)399-5233 |
| Carl Zeiss, Inc. Booth 3
One Zeiss Drive
Thornwood, NY 10594
(914)681-7792 | Medtronic Neurological Booth 12
800 53 rd Avenue NE
Minneapolis, MN 55421
(612)514-5614 |
| Codman/Johnson & Johnson
Professional, Inc. Booth 10
325 Paramount Drive
Raynham, MA 02760
(508)880-8333 | Medtronic PS Medical Booth 14
125 Cremona
Goleta, CA 93117
(805)968-1546 |
| Colorado Biomedical, Inc. Booth 16
6851 Highway 73
Evergreen, CO 80439
(303)674-5447 | Midas Rex, L.P. Booth 26
3000 Race Street
Ft. Worth, TX 76111
(817)831-2604 |
| Cook, Inc. Booth 30
P.O. Box 489
Bloomington, IN 47402
(812)339-2235 | Mosby/Williams & Wilkins Booth 25
P.O. Box 1168
Saratoga Springs, NY 12866
(518)893-2018 |
| Ellman International, Inc. Booth 27
1135 Railroad Avenue
Hewlett, NY 11557
(516)569-1482 | NeuroCare Group Booth 32
8401-102 nd Street
Pleasant Prairie, WI 53158
(414)947-4900 |

Exhibitor Listing (cont.)

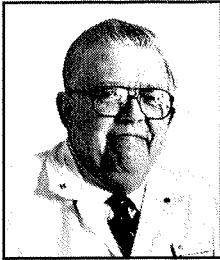
NMT Neurosciences Booth 37 3450 Corporate Way, Suite A Duluth, GA 30096 (678)282-0500	Surgical Solutions, L.L.C. Booth 11 #6 127 Ivy Drive Charlottesville, VA 22903 (973)379-1687
Phoenix Biomedical Corp. Booth 1 2495 General Armistead Avenue Norristown, PA 19403 (610)539-9300	Synergetics, Inc. Booth 18 88 Hubble Drive St. Charles, MO 63304 (314)939-5100
Radionics Booth 5 22 Terry Avenue Burlington, MA 01803 (781)272-1233	W. Lorenz Surgical, Inc. Booth 20 1520 Tradeport Drive Jacksonville, FL 32218 (904)741-4400

Officers of the AANS/CNS Section on Pediatric Neurological Surgery

Chairman:	Marion L. Walker
Secretary-Treasurer:	Thomas G. Luerssen
Executive Council:	Bruce A. Kaufman Mark S. Dias Andrew D. Parent C. Scott McLanahan
Membership Committee:	Ann-Christine Duhaime, Chairman
Rules and Regulations:	Alan R. Cohen
Nominating Committee:	Harold Rekate, Chairman
Ad Hoc Committees	
Traveling Fellowship:	R. Michael Scott, MD
Distinguished Service Award:	Robin P. Humphreys, MD
Neurosurgery On-Call Website:	Mark S. Dias, MD
Publications Committee:	Arthur E. Marlin, MD
Liaison to the AANS Sections:	Harold L. Rekate, MD (1997)
Liaison to the American Academy of Pediatrics:	Joseph H. Piatt, Jr., MD (1997)
Liaison to the Joint Council of State Neurosurgical Societies:	C. Scott McLanahan, MD (1995)
Representatives to CPT Coding Committee:	Joseph H. Piatt, Jr., MD (1995) I. Richmond Abbott, MD (1995)
Representative to Referral Guidelines Committee:	Harold L. Rekate, MD (1997)
Representatives to Practice Guidelines Committee:	Thomas G. Luerssen, MD (1996) John Kestle, MD (1996)
Representatives to Outcomes Committee:	Bruce A. Kaufman, MD (1997) John Kestle, MD (1997)

Franc Ingraham Lifetime Achievement Award

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E. Bruce Henderick even today, is a rare Torontonians who was actually born in the city that he practiced and still resides. He completed high school there and then during WWII was fast-tracked through the University of Toronto medical school, graduating in 1946. After a brief flirtation with family practice in northern Ontario, which acquired skills he proudly called upon throughout his subsequent career, Bruce returned to the surgical training program at his alma mater. After finishing the general surgical requirements

he entered the university's newly created neurosurgical program and in 1952 he traveled to Boston to begin a 2-year fellowship at the Children's Medical Center and the Peter Bent Brigham Hospital where he studied under Franc Ingraham and Donald Matson. About this decision he confessed that "I know very little about Ingraham and Matson and nothing about pediatrics." He remained proud of that experience and treasured forever the teachings of his two masters.

Bruce returned to Toronto in 1954 to begin neurosurgical practice at The Hospital for Sick Children (HSC). Although he shouldered adult responsibilities at the Toronto Western Hospital, it was clear that his joy came from caring for children's neurosurgical disorders, as he swept about the hospital entrancing students young and old. It was not long before he confined his practice to children's neurosurgery thus becoming Canada's first full-time pediatric neurosurgeon. In 1964 he was appointed Neurosurgeon Chief at HSC and during the next 22 years Bruce attracted young men and women from all parts of the globe for training in pediatric neurosurgery. Many neurosurgical units have been established not only in North America but also in several foreign countries as direct result of his stimulation of these surgeons.

Bruce has been part of the birth and maturation of our specialty. He assisted with the creation of the Pediatric Section of the American Association of Neurological Surgeons and subsequently served a term on the Association's Board of Directors. He was a founding member of the International Society for Pediatric Neurosurgery and the American Society of Pediatric Neurosurgeons. He is a past-president of the Canadian Neurosurgical Society. Bruce has also participated on the editorial boards of *Child's Brain*, *Journal of Child Neurology* and he was first Editor-in-chief of *Pediatric Neuroscience* (now known as *Pediatric Neurosurgery*). His own publications include 115 papers and book chapters.

During his professional career from which he retired in 1990, Bruce's lasting devotion has been to his small patients. And, over the years, he has enjoyed the tremendous support of Gloria who has been an outstanding role model for so many spouses of his students who have taken on the challenges of a neurosurgical career.

1998 Raimondi Lecturer

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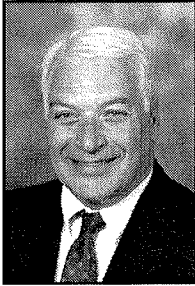
Robert Zimmerman was born in Philadelphia in 1938. He graduated from Central High School and Temple University. He then attended medical school at Georgetown University School of Medicine where he graduated Summa Cum Laude. He interned in medicine there before undertaking his residency in Radiology followed by a fellowship in Special Procedures at the Hospital of the University of Pennsylvania. Following his military service, he joined the faculty of the University of Pennsylvania. At this time he began a long and fruitful association with the Children's Hospital of Philadelphia. He is now Professor of Radiology and Professor of Radiology in Neurosurgery at the University of Pennsylvania. He is the Chief of the Section of Pediatric Neuroradiology and Chief of Magnetic Resonance Imaging at the Children's Hospital of Philadelphia.

Dr. Zimmerman has published over 330 papers and 71 book chapters and reviews. He is the Editor-in-Chief, USA, of *Neuroradiology*. His current funded research activities includes work in neonatal seizures, mental retardation and development delay, neurofibromatosis, and the use of spectroscopy in the evaluation of the response to treatment of brain tumors and the use of spectroscopy in disorders such as ataxia telangiectasia, Down Syndrome, and Canavan's Disease. He is also working to map the developing brain as to its biochemistry and function as demonstrated by functional MRI.

Dr. Zimmerman is a widely sought after speaker and continues to lecture extensively around the world at conferences and as visiting professor. He is also a member of numerous international and national societies, including some neurosurgical societies.

Dr. Zimmerman and his wife, Dianne, are the parents of two children, Rachel and Sara.

Welcoming Address and Opening Remarks Speaker



Born in New York City in 1935, **Dr. Jay L. Grosfeld** attended undergraduate school at the Washington Square College at New York University where he received a B.S. in Biology and History. In 1957, he entered medical school at the New York University School of Medicine graduating in 1961. He is a member of both Phi Beta Kappa and Alpha Omega Alpha. In 1961, he joined the surgical resident staff at NYU and Bellvue Hospitals. He completed his residency in 1966, and after two years as a Captain in the Army Medical Corps, he trained in Pediatric Surgery at the Columbus

Children's Hospital at Ohio State University from 1968-70. He returned to NYU as an Assistant Professor of Surgery in 1970, and only two years later was made the first Professor and Director of Pediatric Surgery at Indiana University and the first Surgeon-in-Chief of the Riley Children's Hospital in Indianapolis. In 1985 he was appointed Chairman of the Department of Surgery at Indiana University, the first pediatric surgeon in the U.S.A. so honored. He is the Training Program Director in both General Surgery and Pediatric Surgery.

Dr. Grosfeld has been honored throughout his surgical career as a master surgeon, teacher and scientific investigator. Dr. Grosfeld has won numerous teaching awards at Indiana University. He is extremely productive and has published more than 419 scientific articles in peer reviewed journals, 95 book chapters and six textbooks. Dr. Grosfeld is best known for his expertise in neonatal surgery and pediatric surgical oncology. He has lectured extensively, both nationally and internationally and has been elected an Honorary Member of numerous overseas surgical societies including Fellowship in the Royal College of Physicians and Surgeons (Glasgow). Dr. Grosfeld is the former Chairman of the American Board of Surgery. He currently serves as Editor-in-chief of the *Journal of Pediatric Surgery* and *Seminars in Pediatric Surgery*, President of the Western Surgical Association, President-elect of the World Federation of Associations of Pediatric Surgeons, Chairman of the Board of the APSA Foundation, and is a member of the ACGME-Residency Review Committee for Surgery.

Dr. Grosfeld has been happily married to Margie for the past 36 years. The Grosfelds have five children and six grandchildren.

Disclosure Information

The AANS/CNS Section on Pediatric Neurological Surgery and The American Association of Neurological Surgeons control the content and production of this CME activity and attempt to assure the presentation of balanced, objective information. In accordance with the Standards for Commercial Support established by the Accreditation Council for Continuing Medical Education, speakers and paper presenters are asked to disclose any relationship they or their co-authors have with commercial companies which may be related to the content of their lecture.

Speakers and paper presenters/authors who have disclosed a relationship* with commercial companies whose products may have a relevance to their presentation are listed below and will be designated throughout the program book by a “†”.

Florence Barnett, MD	Avigen
Stefan Bluml, PhD	Rudi Schulte Research Institute, Huntington Medical Research Institute, Neurosurgical Unit Children's Hospital
Xingang Cai, MD	Wade's Center for Hydrocephalus Research, Health Research Institute, Orlando Regional Healthcare System
Hugh Garton, MD	Medtronic PS Medical and Cordis/Elekta
Dan Lieberman, MD	Codman, Inc.
Tomoko Ozawa, MD, PhD	NIH Grant, Phi Beta Psi Grant
Jogi Pattisapu, MD	Wade's Center for Hydrocephalus Research, Health Research Institute, Orlando Regional Healthcare System
Banjamin Peltesen, MD	Wade's Center for Hydrocephalus Research, Health Research Institute, Orlando Regional Healthcare System
Ian F. Pollack, MD	NIH Grant

* Relationship refers to receipt of royalties, consultantship, funding by research grant, receiving honoraria for educational services elsewhere, or any other relationship to a commercial company that provides sufficient reason for disclosure.

Program of the AANS/CNS Section on Pediatric Neurological Surgery

27th Annual Meeting

Jointly sponsored by The American Association of Neurological Surgeons

Program Schedule

TUESDAY, DECEMBER 1

12:00 NOON–5: 00 PM	Nurses Seminar – Chamber Room
2:00 PM– 5:00 PM	Executive Committee Meeting – Caucus Room
2:00 PM–8: 00 PM	Registration – Grand Ballroom Foyer 4
2:00 PM– 8:00 PM	Speaker Preview Room – House Room
2:00 PM– 6:00 PM	Poster Setup – Grand Ballroom 1-4
6:00 PM–8: 00 PM	Welcoming Reception – Grand Ballroom 5

WEDNESDAY, DECEMBER 2

7:00 AM–6:00 PM	Registration – Grand Ballroom Foyer 4
7:00 AM–6:00 PM	Speaker Preview Room – House Room
7:00 AM–8:15 AM	Continental Breakfast with Exhibits and Poster Viewing – Grand Ballroom 1-4
7:00 AM–8: 15 AM	Breakfast Seminar I: The Pediatric Neurosurgeon and the Young Athlete – Grand Ballroom 5 Moderator: Thomas G. Luerssen, MD Faculty: Henry Feuer, MD, R. Alexander Sanford, MD
7:00 AM–11:00 AM & 1:30 PM–5:30 PM	Exhibit and Poster Viewing Hours – Grand Ballroom 1-4
8:00 AM–10:00 AM	Spouse Hospitality – Cameral Room
8:15 AM–8:30 AM	Welcome and Opening Remarks – Grand Ballroom 5 Jay L. Grosfeld, MD
8:30 AM–9:45 AM	Scientific Session I – Grand Ballroom 5 Craniofacial and Skull Base Surgery Moderators: Frederick A. Boop III, MD, Ann Marie Flannery, MD

8:30 AM–8:45 AM

1. Surgical Approaches to the Pediatric Skull Base: Experience and Outcomes in 51 Patients*

David Gruber, MD, Lyn Carey, MD, Jeffrey Haller, Marion Walker, MD, Clough Shelton, MD, Douglas Brockmeyer, MD (*Salt Lake City, UT*)

8:45 AM–9:00 AM

2. Endoscopic Transoral Approach to the Craniovertebral Junction

Alan Cohen, MD

9:00 AM–9:15 AM

3. Evaluation and Treatment of Sincipital Encephaloceles: Report of 38 Consecutive Cases

David Jimenez, MD, Constance M. Barone, MD (*Columbia, MO*)

9:15 AM–9:30 AM

4. Cranial Congenital Dermal Sinuses: Evaluation and Outcomes*

Joseph Chen, MD, Geoffrey Pableo, BA, SooHo Choi, MD, Michael L. Levy, MD, J. Gordon McComb, MD (*Los Angeles, CA*)

9:30 AM–9:45 AM

5. The Reversal Exchange Technique of Total Calvarial Reconstruction for Sagittal Craniosynostosis in Infants

Joseph Fata, MD, Michael S. Turner, MD

9:45 AM–10:15 AM

Coffee Break with Exhibit and Poster Viewing – Grand Ballroom 1-4

10:30 AM–11:30 AM

Scientific Session II – Grand Ballroom 5 Spasticity

Moderators: Bruce B. Storrs, MD,
Michael S. Turner, MD

10:15 AM–10:30 AM

6. Changes in Ankle Spasticity and Strength as a Result of Selective Dorsal Rhizotomy

Jack R. Engsberg, PhD, Sandy A. Ross, MHS, Kenneth S. Olree, MS, T.S. Park, MD (*St. Louis, MO*)

10:30 AM–10:45 AM

7. Does the Amount of Rootlet Sectioning in Selective Dorsal Rhizotomy Correlate to the Improvement in Spasticity at That Level?

Toru Fukuhara, MD, Imad M. Najm, MD, Kerry Levin, Mark G. Luciano, MD, PhD (*Cleveland, OH*)

**Considered for Shulman Award*

10:45 AM–11:00 AM

8. Nonselective Partial Dorsal Rhizotomy: A Clinical Study With One Year Follow Up*

David Sacco, MD, Chester Tylkowski, MD, Benjamin Warf, MD
(Lexington, KY)

11:00 AM–11:15 AM

9. Mid-thoracic Catheter Tip Placement for Baclofen Administration in Children with Quadriparetic Spasticity

Paul Grabb, MD, Amy Pittman, RN, Sharon Renfroe, RN, Jay Meythaler, MD
(Birmingham, AL)

11:15 AM–11:30 AM

10. Subfascial Placement of Baclofen Pumps

Paul Grabb, MD, Amy Pittman, RN (Birmingham, AL)

**11:30 AM–12:30 PM The 1998 Raimondi Lecture – Grand Ballroom 5
Advances in Magnetic Resonance Imaging of the
Pediatric Nervous System**

Robert A. Zimmerman, MD

Professor of Radiology and Neurosurgery
University of Pennsylvania School of Medicine
Chief, Pediatric Neuroradiology
The Children's Hospital of Philadelphia

Introduced by Ann-Christine Duhaime, MD

**12:30 NOON–2:00 PM Lunch for all Medical Registrants –
Capitol Ballroom 1 & 2**

**2:00 PM–3:00 PM Scientific Session III – Grand Ballroom 5
Tumor**

Moderators: Alan R. Cohen, MD,
Jeffrey H. Wisoff, MD

2:00 PM–2:15 PM

**11. Implantation of Medulloblastoma Cells into Collagen Type I Gels:
Invasiveness, Enzymatic Characterization and the Impact of Surgical
Excision and Radiation***

Adrianna Ranger, MD, Warren McDonald, BSc, MLT, Emi Moore, BSc
MLT, Rolando F. DelMaestro, MD, PhD, FRCS (C) (London, Ont)

2:15 PM–2:30 PM

**12. Bone Morphogenetic Proteins 2 and 4 Attenuate Apoptosis in a
Cerebellar Primitive Neuroectodermal Tumor Cell Line***

Mark Iantosca, Clifton E. McPherson, PhD, Shih-Yieh Ho, PhD,
Gerald D. Maxwell, PhD (Farmington, CT)

**Considered for Shulman Award*

2:30 PM–2:45 PM

13. Growth Regulated Oncogene in Oligodendrogliomas: Constitutive Activation of a Proliferative Pathway Used during Development

Shenandoah Robinson, MD, Joel Levine, PhD (*Syracuse, NY*),
Mark Cohen, MD (*Cleveland, OH*), Robert H. Miller, PhD (*Cleveland, OH*)

2:45 PM–3:00 PM

14. In Vitro Model for Treatment of Disseminated Neoplastic Processes*

Florence Barnett, MD[†], James Fick, MD (*Augusta, GA*)

3:00 PM–3:15 PM

15. Growth Kinetics of Pediatric Low Grade Gliomas

Jorge Lazareff, MD, Rafal Suwinski MD, PhD, Roberto De Rosa MD,
Charles Olmstead, PhD

3:15 PM–3:30 PM

16. Post-Treatment Choline Signal Intensity in Pediatric Gliomas

Jorge Lazareff, MD, Rakesh Gupta, MD, Jaime Nieto, MD, Jeffrey Alger, PhD

3:30 PM–3:45 PM

17. Second Brain Tumors Following Radiation and Chemotherapy

C. L. Bonasso, MD, D. Boue', MD, E. Kosnik, MD (*Columbus, OH*)

3:45 PM–4:00 PM

18. Focal Tectal Lesions in Late-Onset Aqueductal Stenosis in Children

Nejat Akalan, MD, Ergün Daglioglu, MD, Aysenur Cila, MD
(*Ankara, Turkey*)

4:00 PM–4:15 PM

**The Franc Ingraham Lifetime Achievement Award –
Grand Ballroom 5**

E. Bruce Hendrick, MD
Professor and Director Emeritus, Department of
Neurosurgery
The Hospital for Sick Children
Toronto, Ontario

Introduced by Robin P. Humphreys, MD
Presented by Marion L. Walker, MD

4:15 PM–5:30 PM

Scientific Session IV – Grand Ballroom 5

Poster Session with Authors
Wine and Cheese provided by PS Medical Corporation

5:30 PM–6:00 PM

Annual Business Meeting – Grand Ballroom 5

**Considered for Shulman Award
†Disclosure Information*

THURSDAY, DECEMBER 3

- 7:00 AM–12:30 PM Registration – Grand Ballroom Foyer 4
- 7:00 AM–8:30 AM Continental Breakfast with Exhibit and Poster Viewing
– Grand Ballroom 1-4
- 7:00 AM–8:30 AM **Breakfast Seminar II – Grand Ballroom 5**
Neuroncology Update
Moderator: James T. Rutka, MD, PhD
Faculty: Ian F. Pollack, MD[†], Corey Raffel, MD, PhD
- 7:00 AM–12:30 PM Exhibit and Poster Viewing Hours –
Grand Ballroom 1-4
- 7:00 AM–12:30 PM Speaker Preview Room – House Room
- 8:00 AM–10:00 AM Spouse Hospitality – Cameral Room
- 8:30 AM–10:10 AM **Scientific Session V – Grand Ballroom 5**
Hydrocephalus I
Moderators: C. Scott McLanahan, MD,
Bruce A. Kaufman, MD

8:30 AM–8:45 AM

19. Impact of Surgical Shunting on Neurometabolic Development of Hydrocephalic Children: A Longitudinal Study with Quantitative Magnetic Resonance Spectroscopy**

Stefan Bluml, PhD[†], Jeannie Tan, BS (*Pasadena, CA*), Kay J. Seymour, PhD (*Pasadena, CA*), Jung-Hee Hwang, PhD (*Pasadena, CA*), Robert S. Pudenz, MD (*Pasadena, CA*), J. Gordon McComb, MD (*Los Angeles, CA*), Brian D. Ross, MD, PhD (*Pasadena, CA*)

8:45 AM–9:00 AM

20. Endoscopic Approach to Non-communicating Fluid Spaces in the Shunted Patient**

Bakhtiar Yamini, MD, Liliana C. Goumnerova, MD (*Boston, MA*), David M. Frim, MD, PhD (*Chicago, IL*)

9:00 AM–9:15 AM

21. In Vitro Detection of Fluid Flow in Ventriculoperitoneal Shunts (VPS) Using Contrast Enhanced Ultrasound**

Dan Lieberman, MD[†], Steven Lester, MD, Martin Holland, MD, Michael Wood, Claude Hemphill, MD, Istvan Matej, Grant Gauger, MD (*San Francisco, CA*)

**Considered for Shulman Award*
†Considered for Hydrocephalus Award
[†]Disclosure Information

9:15 AM–9:30 AM

- 22. Cerebral Pseudoaneurysm Rupture and Hemiplegia following Thermocoagulation of Proximal Catheter During Shunt Revision**
Azedine Medhkour, MD, W. Bruce Cherny, MD, C.A. James, MD
(*Little Rock, AR*)

9:30 AM–9:45 AM

- 23. Percutaneous Endoscopic Shunt Recanalization—Long Term Results in 20 Cases**
Jogi Pattisapu, MD[†], Eric Trumble MD, Kay Taylor RN, Denise Howard, CT, Tina Kovacs, RN

9:45 AM–10:00 AM

- 24. Treatment of Cerebrospinal Fluid Shunt Infections****
William E. Snyder, Jr., MD, Joel C. Boaz, MD, Abdolreza Siadati, MD, John E. Kalsbeck, MD, Thomas G. Luerssen, MD, Martin P. Kleiman MD
(*Indianapolis, IN*)

10:00 AM–10:30 AM Coffee Break with Exhibit and Poster Viewing – Grand Ballroom 1-4

- 10:30 AM–12:30 PM Scientific Session VI – Grand Ballroom 5
Dysraphism**
Moderators: Mark S. Dias, MD,
Walker L. Robinson, MD

10:30 AM–10:45 AM

- 25. Coccygeal Pits***
Bradley Weprin, MD, W. Jerry Oakes, MD (*Birmingham, AL*)

10:45 AM–11:00 AM

- 26. Anorectal Malformations and Spinal Dysraphism**
Robert Keating, MD, C.M. Shaer, D.W. Pincus, L.J. Haga, K. Newman, P.H. Cogen (*Washington, DC*)

11:00 AM–11:15 AM

- 27. Analysis of 42 Patients Operated Upon for Lumbosacral Lipoma***
Jeffrey Lee, MD, Warwick J. Peacock, MD (*San Francisco, CA*)

11:15 AM–11:30 AM

- 28. Tethered Cord Syndrome in Children with the Conus in a Normal Position**
Monica C. Wehby-Grant, MD, Patrick S. O'Hollaren, MD, Colleen D. Phillips, PA-C (*Portland, OR*)

*Considered for Shulman Award

†Considered for Hydrocephalus Award

¹Disclosure Information

11:30 AM–11:45 AM

29. The Effect of Surgery for Diastematomyelia on Neurologic and Urologic Function

Mark Proctor, MD, Stuart Bauer, MD, Michael Scott, MD, Lilliana Goumnerova, MD, Joseph Madsen, MD, Mary Kelly, RN, Mary Darbey, RN (*Boston, MA*)

11:45 AM–12:00 NOON

30. New Insights in the Development of the Secondary Neural Tube and Secondary Neural Tube Defects

Timothy George, MD

12:00 NOON–12:15 PM

31. Clustering of Neural Tube Defects by Location Along the Rostrocaudal Axis—Genetic Implications

Timothy George, MD, Marcy C. Speer, PhD, Herbert E. Fuchs, MD, PhD (*Durham, NC*), NTD Collaborative Group

12:15 PM–12:30 PM

32. Intrauterine Myelomeningocele Repair: Its Effect on the Chiari Malformation

Noel Tulipan, MD, Marta Schulman, MD, Joseph P. Bruner, MD (*Nashville, TN*)

12:30 PM–2:00 PM

**Special Luncheon Seminar for Residents and Fellows –Capitol Ballroom 1 & 2
Training, Certification, and Careers in Pediatric Neurosurgery**

Moderators: David G. McLone, MD, PhD,
Marion L. Walker, MD

2:00 PM–6:30 PM

Free Afternoon

6:30 PM–11:00 PM

Annual Reception and Dinner – Capitol Ballroom

FRIDAY, DECEMBER 4

- 7:00 AM–4:00 PM Registration – Grand Ballroom Foyer 4
- 7:00 AM–8:30 AM Continental Breakfast with Exhibit and Poster Viewing
– Grand Ballroom 1-4
- 7:00 AM–8:30 AM** **Breakfast Seminar III – Grand Ballroom 5**
Subtle Forms of CSF Shunt Dysfunction (With Particular Reference to the Special Role of the Patient in Shunt Function)
Moderator: Harold L. Rekate, MD
Faculty: James M. Drake, MD, BCh, Joseph H. Piatt, Jr. MD
- 7:00 AM–3:00 PM Exhibit and Poster Viewing Hours –
Grand Ballroom 1-4
- 7:00 AM–5:00 PM Speaker Preview Room – House Room
- 8:00 AM–10:00 AM Spouse Hospitality – Cameral Room
- 8:30 AM–10:00 AM** **Scientific Session VII – Grand Ballroom 5**
Functional/ Epilepsy
Moderators: Joseph R. Madsen, MD,
Ann-Christine Duhaime, MD
- 8:30 AM–8:45 AM
- 33. First Reported Cases of Hemifacial Spasm as the Presenting Finding in Three Patients with Lhermitte-Duclos Syndrome**
Charles Kanos, M.D., Robert A Sanford, MD (*Memphis, TN*), Michael Muhlbauer, MD (*Memphis, TN*), Derek Bruce, MD (*Dallas, TX*)
- 8:45 AM–9:00 AM
- 34. Functional Reorganization In The Homunculus: Electrocorticographic Evidence**
John Honeycutt, MD, Paul Francel, MD, PhD, K.J. Oomen
(*Oklahoma City, OK*)
- 9:00 AM–9:15 AM
- 35. Cognitive Outcome For Pediatric Patients Following Selective Amygdalo-Hippocampectomy**
Lynn B. Blackburn, PhD, Shenandoah Robinson, MD (*St. Louis, MO*), T.S.Park, MD (*St. Louis, MO*), Blaise F. D. Bourgeois, MD (*Boston, MA*)
- 9:15 AM–9:30 AM
- 36. Multi-Stage Epilepsy Surgery in the Pediatric Population: Preliminary Results**
Alon Mogilnor, MD, PhD, Werner K. Doyle, MD, Steven V. Pacia, MD, Orrin Devinsky, MD, Jeffrey H. Wisoff, MD, Howard L. Weiner, MD
(*New York, NY*)

**Considered for Shulman Award*

9:30 AM–9:45 AM

37. Recent Surgical Management of Epilepsy in Children with Cortical Dysplasia

Mark Lee, MD, PhD, Karl Sillay, Joseph R. Smith, MD, FACS
(*Augusta, GA*)

9:45 AM–10:00 AM

38. Pallidotomy as a Treatment Option for Pediatric Movement Disorders

Charles Teo, MD

10:00 AM–10:30 AM

Coffee Break with Exhibit and Poster Viewing – Grand Ballroom 1-4

10:30 AM–12:30 NOON

Scientific Session VIII – Grand Ballroom 5 Tumors II

Moderators: Corey Raffel, MD, PhD,
J. Parker Mickle, MD

10:30 AM–10:45 AM

39. Clinical Presentation of Optic Pathway Tumors in Young Children with NF1

Kimberly Bingaman, MD, Joseph Petronio, MD, Arlene Drach, MD
(*Atlanta, GA*)

10:45 AM–11:00 AM

40. Interhemispheric Transcallosal Resection of Mass Lesions in Childhood: Review of 12 Years Experience*

Mark A. Mittler, MD, Michael L. Levy, MD, J. Gordon McComb, MD

11:00 AM–11:15 AM

41. A Contemporary Algorithm for the Management of Posterior Third Ventricular Tumors

Sivakumar Jaikumar, MD, Mark Davies, MD (*Sydney, NSW, Australia*),
Charles Teo, MD (*Little Rock, AR*)

11:15 AM–11:30 AM

42. Radical Therapy of Choroid Plexus Carcinoma

George Malcolm, MD, Edward Chow, MD, Robert A Sanford, MD,
Larry Kun, MD (*Memphis, TN*)

11:30 AM–11:45 AM

43. Pineal Location PNETs in Children*

Michael Wang, Steve W. Chang, MD, Mark A. Mittler, MD, Michael L. Levy, MD, J. Gordon McComb, MD

**Considered for Shulman Award*

11:45 AM–12:00 NOON

44. High-grade Astrocytomas in Children

Li Anmin, MD, Zhang Xiang, MD (*Peoples Republic of China*)

12:00 NOON–12:15 PM

45. The Role of High-Dose Chemotherapy (HDC) and Autologous Stem Cell Rescue (ASCR) in the Treatment of Malignant Gliomas of Childhood

Howard L. Weiner, MD, Mark V. Sapp, MD, Sharon Gardner, MD, Jeffrey H. Wisoff, MD, Jonathan L. Finlay, MB, ChB (*New York, NY*)

12:15 PM–12:30 PM

46. A Multi-Institutional Retrospective Study of Intracranial Ependyoma in Children: Identification of Risk Factors

Matthew Smyth, MD, Biljana Horn, MD, Mitchel S. Berger, MD (*San Francisco, CA*), Richard Heideman, MD (*Memphis, TN*), Russel J. Geyer, MD (*Seattle, WA*), Ian Pollack, MD (*Pittsburg, PA*), Roger Packer, MD (*Washington, DC*), Joel Goldwein, MD (*Philadelphia, PA*), Tandori Tomita, MD (*Chicago, IL*), Paula Schomberg, MD (*Rochester, MN*), Joan Ater, MD (*Houston, TX*), Lori Luchtman-Jones, MD (*St. Louis, MO*), Kenneth Rivlin, MD, PhD (*New York, NY*), Kathleen Lamborn (*San Francisco, CA*), Michael Prados, MD (*San Francisco, CA*), Andrew Bollen, MD (*San Francisco, CA*), Mitchel Berger, MD (*San Francisco, CA*), Gary Dahl, MD, Steve Huhn, MD (*Palo Alto, CA*), Elizabeth McNeil (*Washington, DC*), Kathleen Patterson, Dennis Shaw, Michael Kubalik, Carolyn Russo, MD (*San Francisco, CA*)

12:30 PM–2:00 PM

**Lunch for all Medical Registrants –
Capitol Ballroom 1 & 2**

2:00 PM–3:30 PM

**Scientific Session IX – Grand Ballroom 5
Trauma**

Moderators: Andrew D. Parent, MD,
Joseph H. Piatt, Jr., MD

2:00 PM–2:15 PM

47. Delayed Repair of Open Depressed Skull Fracture*

Daniel Curry, MD, David M. Frim, MD, PhD (*Chicago, IL*)

2:15 PM–2:30 PM

48. Post-Traumatic Seizures in Children: Is Routine Admission Necessary?

Mark Dias, MD, Frank Carnevale, MD, Veetai Li, MD (*Buffalo, NY*)

**Considered for Shulman Award*

2:30 PM–2:45 PM

49. Neurological Deterioration after Closed Head Injury in Childhood: Incidence and Outcome*

Jill W. Donaldson, MD, Hugh J. L. Garton, MD, William E. Snyder, Jr., MD, Thomas G. Luerssen, MD (*Indianapolis, IN*)

2:45 PM–3:00 PM

50. Intracranial Pressures During Normal Care, Accidental Injury, Intentional Abuse and CPR in a Model Infant

Eric Adelman, Kristin Marit Mawk, John R. Mawk, MD (*Des Moines, IA*)

3:00 PM–3:15 PM

51. Spinal Cord Injuries in Fatal Inflicted Trauma in Infants

Ann-Christine Duhaime, MD, Cindy Christian, MD, Lucy B. Rorke, MD (*Philadelphia, PA*)

3:15 PM–3:30 PM

52. Non-Accidental CNS Injury in Children and Judicial Outcome

Stephen Huhn, MD, Catherine Albin, MD, Michele M. McCoy, JD (*San Jose, CA*)

3:30 PM–4:00 PM

Coffee Break with Exhibit and Poster Viewing – Grand Ballroom Foyer 4

4:00 PM–5:30 PM

**Scientific Session X – Grand Ballroom 5
Hydrocephalus II**

Moderators: Yoon Sun Hahn, MD,
Joseph J. Petronio, MD

4:00 PM–4:15 PM

53. Ventricular Anatomy and Shunt Catheters

Bruce A. Kaufman, MD, T.S. Park, MD (*St. Louis, MO*)

4:15 PM–4:30 PM

54. Ventricular Catheter Tip Location: Predictive Probability of the Surgeons Aim and Effect on Shunt Failure—Results from the Pediatric Shunt Design Trial **

Sagun Tuli, MD, B. O'Hayon, Michelle Clark, J.M. Drake (*Toronto, Ontario*), J.R.W. Kestle (*Vancouver, British Columbia*)

**Considered for Shulman Award*

†Considered for Hydrocephalus Award

‡Disclosure Information

4:30 PM–4:45 PM

55. A Cost Effectiveness Evaluation of Endoscopic 3rd Ventriculostomy

Hugh Garton, MD[†], John R.W. Kestle, MD, Douglas Cochrane, MD,
Paul Steinbok (*Vancouver, BC*)

4:45 PM–5:00 PM

56. Neonatal Ventriculosubgaleal Shunts**

Benjamin Fulmer, MD, Paul Grabb, MD, Jerry Oakes, MD, Timothy
Mapstone, MD (*Birmingham, AL*)

5:00 PM–5:15 PM

**57. Ventriculo-Subgaleal Shunts for Hydrocephalus in Small Premature
Infants**

Michael Handler, MD, FACS, FAAP, Patti Batchelder, RN, MSN
(*Denver, CO*)

5:15 PM–5:30 PM

**58. In Vivo Ventricular Pressure Dynamics When Shunting CSF to
Unusual Absorptive Surfaces: A Telemetric Study**

David Frim, MD, PhD, Ilyas Munshi, MD (*Chicago, IL*), Lilliana
Goumnerova, MD (*Boston, MA*), Joseph Madsen, MD (*Boston, MA*),
Dawn Lathrop, RN (*Chicago, IL*)

5:30 PM

Closing Comments

[†]*Considered for Hydrocephalus Award*

Poster Session

- 1. The Combined Use of Hydroxyapatite Cement and Absorbable Plating for the Repair of Complex Cranial Defects**
James Brennan, MD, Paul C. Francel, MD, W. David Min, MD
(*Oklahoma City, OK*)
- 2. Use of Bioresorbable “Pop Rivets” and Plates in Pediatric Craniofacial Surgery: A New Fixation Technique**
Paul Francel, MD, PhD, Kevin S. Smith, DDS (*Oklahoma City, OK*)
- 3. WITHDRAWN**
- 4. Extensive Oligodendroglia Proliferation in an Encephalocele**
Boleslaw Liwnicz, MD, PhD, Y.Y. Ying (*Loma Linda, CA*)
- 5. Split Cord Malformation and Myelomeningocele. Report of Seven Cases**
Santiago Portillo, MD, Adrian Fernandez, Carlos Moyano, Cesar Petre, Pedro Picco (*Buenos Aires, Argentina*)
- 6. Surgical Resection of Intraspinal Lipomas**
Santiago Portillo, MD, Adrian Fernández, Carlos Moyano, Cesar Petre, Pedro Picco, (*Buenos Aires, Argentina*)
- 7. Surgical Treatment of Adult Spinal Lipoma by Loosening of the Responsible Spinal Nerve Roots and Conus**
Yasuko Yoshida, MD, Reizo Shirane, MD, Takashi Ysohimoto, MD
(*Sendai, Japan*)
- 8. Addition of Elemental Iodine to Surgical Irrigation for Neurosurgical Procedures**
SooHo Choi, MD, J. Gordon McComb, MD, Michael L. Levy, MD, Ignacio Gonzalez, MD, Berislav Zlokovic, MD (*Los Angeles, CA*)
- 9. Pediatric Neurosurgery Workforce: Results of a 1997 Survey**
Ann Marie Flannery, MD (*Augusta, GA*)
- 10. Peroxynitrite Mediates Acute Cerebrovascular Inflammation Following Asphyxia in Neonatal Piglets**
T. S. Park, MD, Jeffrey M. Gidday, PhD, Ernesto R. Gonzales, BSN, Stuart S. Kaplan, MD (*St. Louis, MO*)

- 11. Pediatric Patients with Spinal Cord Compromise Due To Complications of Proteus Syndrome**
Heather Halpin Richardson, Ann Marie Flannery, MD, Mark Lee, MD, PhD,
Michael Cowan, MD (*Augusta, GA*)
- 12. Perioperative Complications and Blood Transfusion Requirement for Adolescent Scoliosis Surgery**
Gregory Wiggins, MD, Christopher Shaffrey, MD, Michael Rauzzino, MD
(*Detroit, MI*)
- 13. TGF-Beta1 Expression is Decreased in H-Tx Rat Brains of Hydrocephalus**
Xingang Cai, MD, Jogi Pattisapu, MD, Jane Gibson, PhD,
Roy Tarnuzzer, PhD(*Gainesville, FL*), Christina Fernandez-Valle, PhD
- 14. Studies of Brain Water in Hydrocephalic and Normal H-Tx Rats**
Xingang Cai, MD, Glenda McGraw, Jogi Pattisapu MD, Jane Gibson, PhD
- 15. Low Pressure Shunt Malfunction Following Lumbar Puncture in Two Children with Shunted Obstructive Hydrocephalus**
Mark Dias, MD, Veetai Li, MD, John Pollina, MD (*Buffalo, NY*)
- 16. Prognostic Factors for Childhood Intracranial Ependymomas**
Kenneth Liu, BA, Wesley Miao, BA, Arun Amar MD, Lena Masri, MS,
Michal Levy, MD, J. Gordon McComb, MD (*Los Angeles, CA*)
- 17. Evaluation of Imaging Modalities for Diagnosis of Hydrocephalic Rats**
Benjamin Peltesen, Katie Pan, Glenda McGraw, Sue Willingham,
Xingang Cai, MD, Jogi Pattisapu, MD
- 18. Endoscopic-Guided Proximal Catheter Placement in Treatment of Posterior Fossa Cysts**
David Sandberg, MD, Mark M. Souweidane, MD (*New York, NY*)
- 19. Evaluation of Shunt Malfunction Using Shunt Site Reservoir**
Sandeep Sood, MD, Alexa I. Canady, MD, Steven D. Ham, DO
(*Detroit, MI*)
- 20. MRI Artifact Mimicking a Temporal Lobe Lesion in an Epilepsy Patient**
Praveen Mummaneni, MD, Warwick J. Peacock, MD (*San Francisco, CA*)
- 21. Magnetic Source Imaging as a Preoperative Diagnostic Tool**
Ronald Young II, MD, James E. Baumgartner, MD

- 22. Mobilizing the Umbilicus for Optimal Placement of a Baclofen Pump**
Michael Handler, MD, FACS, FAAP
- 23. Evaluation of Intrathecal Drug Infusion Pump Function**
Michael Turner, MD
- 24. Television Set Head Injuries in Children**
Jeremy Denning, MS4, James Baumgartner, Ron Young, III, MD,
Linda Ewing-Cobb (*Houston, TX*)
- 25. Children Killing Children: Treating the Spreading Epidemic**
Mimi Sutherland, RN MS CNRN, Phil Aldana, MD, David Petrin, RN,
Dan Frank, MD, John Ragheb, MD (*Miami, FL*)
- 26. Juvenile Pilocytic Astrocytoma in Infants. Columbus Children's Hospital Experience**
Philip Hodge, MD, Edward J. Kosnik, MD (*Columbus, OH*)
- 27. MRI Assessment of Spinal Cord Movement**
Robert R. C. Jones, MD, John Periria
- 28. Unusually Rapid Growth of Subependymal Giant Cell Astrocytoma**
Azedine Medhkour, MD, Charles Teo, MD, Charles M. Glasier, MD
(*Little Rock, AR*)
- 29. Ganglion Cell Tumor of the Cerebellum with Extensive Involvement of the Cervicothoracic Spinal Cord**
Renatta J. Osterdock, MD, Liliana C. Goumnerova, MD (*Boston, MA*)
- 30. In Vitro Cytotoxicity of Phenylacetate in Human Medulloblastoma Cell Lines**
Tomoko Ozawa, MD, PhD, Lily Hu, MS, Michael D. Prados, MD,
Dennis F. Deen, PhD (*San Francisco, CA*)
- 31. A Case of Supratentorial Dermoid Tumour**
Ishwar Chandra Premsagar, MD, A.K. Srivastava, MD
- 32. Sickle Cell Disease and Moyamoya Syndrome Treated with Encephaloduroarteriosynangiosis**
Robert E. Tibbs, Jr., MD, Adam I. Lewis, MD (*Jackson, MS*)
- 33. The Occurrence of Congenital Pediatric Aneurysms**
Robert Tibbs, MD, Kevin R. Killough, MD, John A. Lancon, MD,
Adam I. Lewis, Andrew D. Parent, MD (*Jackson, MS*)

Scientific Abstracts*†

**Considered for Shulman Award*
†Considered for Hydrocephalus Award

1. Surgical Approaches to the Pediatric Skull Base: Experience and Outcomes in 51 Patients*

David Gruber, MD, Lyn Carey, MD, Jeffrey Haller, MD, Marion Walker, MD, Clough Shelton, MD, Douglas Brockmeyer, MD (*Salt Lake City, UT*)

Introduction: Modern skull base approaches are integral in the multidisciplinary management of complex cranial base pathology. However, experience with this team approach, as well as its related techniques has not been well described in the pediatric literature. We present our recent experience with pediatric skull base surgery as well as discuss developmental and anatomical issues critical to its success.

Materials and Methods: A retrospective analysis of 51 patients under 16 years of age who underwent skull base surgery at the Primary Children's Medical Center or University of Utah Medical Center between January, 1992, and August, 1998 was completed. The surgical indications included a need for improved exposure without excessive brain retraction, and a requirement to provide an adequate operative corridor. Outcome data was culled from hospital charts.

Results: There were 26 boys and 25 girls (mean age: 4.1 years). Most patients had pathology that mandated either an anterior or antero-lateral approach; 6 patients underwent a far-lateral or transpetrosal exposure. Ninety six percent (n=49) of patients had a Glasgow Outcome Score of either 1 or 2. Complications included two mild hemipareses and 11 transient cranial nerve palsies. Four cranial nerve palsies were sustained beyond 6 months. There were no CSF leaks, infections, or deaths.

Conclusions: Surgical exposure for pathology of the pediatric skull base can be implemented effectively with the use of a multidisciplinary team. Knowledge of the limitations of these techniques, and of the differences between the adult and child cranial base is essential.

2. Endoscopic Transoral Approach to the Craniovertebral Junction

Alan Cohen, MD

A major difficulty presented by midline ventral lesions at the craniovertebral junction is their relative inaccessibility. Posterolateral approaches are useful, but require retraction of neural structures and provide a restricted view of the midline. The transoral approach is the most direct route to ventral lesions from the mid-clivus to C-2.

A limitation of the transoral approach is the small aperture between the upper and lower teeth. Traditionally, transoral surgery is performed using the operating microscope, but visualization of deep structures may be difficult. Recent advances in optics have permitted the use of endoscopes to enhance visualization of structures at the skull base. It seems logical that endoscopic techniques could be applied to improve transoral surgery.

The author has developed an endoscope for use in the transoral exposure of the craniovertebral junction. The endoscope consists of a rod-lens mounted to the circular ring of a transoral retractor. The lens enters the oral cavity along the tongue retractor. A prism allows the eyepiece to be angled and brought away from the mouth. The image is projected onto a television monitor via a charge-coupled-device camera mounted on the ocular. The entire procedure is conducted under endoscopic guidance. Surgical instruments are introduced through an unencumbered corridor adjacent to the lens.

The endoscopic transoral approach provides a panoramic view of the ventral skull base that is superior to that provided by the microscope. The present report demonstrates its feasibility in a cadaver. The technique should prove useful clinically, and may extend the neurosurgical indications for transoral surgery.

3. Evaluation and Treatment of Sincipital Encephaloceles: Report of 38 Consecutive Cases

David Jimenez, MD, Constance M. Barone, MD (*Columbia MO*)

Purpose: Presented is an approach, coined the “nasional” craniotomy, which is single stage resection and reconstruction of medium to large encephaloceles resected through the nasion and avoiding bifrontal craniotomy.

Methods: 38 patients with sincipital encephaloceles were operated on between January 1994 and August 1997. 24 males and 14 females with ages ranging between 2 months and 22 years (mean = 5.5 yrs). Location of the encephaloceles was: nasofrontal - 2, naso-orbital - 2, nasoethmoidal - 29, combination - 3. Twenty-one (55%) patients had nasolacrimal duct obstruction and 10.5% hydrocephalus. Seven patients underwent a classic bifrontal craniotomy. Thirty-one patients underwent nasional craniotomy i.e. removal of the nasal bone only, and inferior glabella resection of the encephalocele, repair of dural defect using vascularized pericranial grafts and nasal remodeling.

Results: Complete resection of the glottic mass was accomplished in all patients without intraoperative complications. Mean operative time for nasional approach was 2.7 hours. The mean blood loss for nasional approach was 110 cc. Two patients developed nasolacrimal duct infections, 1 superficial cellulitis of the forehead, 1 pseudomeningocele. There were no CSF leaks.

Conclusion: Results indicate that the single stage multidisciplinary approach provides a safe and minimally invasive approach to the management of these patients. Use of nasional craniotomy eliminated the need for bifrontal craniotomy and ligation of the sagittal sinus. The majority of the patients obtained excellent cosmetic results. The surgical technique and clinical results, including follow-up, will be presented.

4. Cranial Congenital Dermal Sinuses: Evaluation and Outcomes*

Joseph Chen, MD, Geoffrey Pableo, BA, SooHo Choi, Michael L. Levy,
J. Gordon McComb, MD (*Los Angeles, CA*)

Congenital dermal sinuses are rare lesions unique amongst the midline dysraphisms in that they may present in childhood with either neurological or infectious complications. We review our series of congenital dermal sinuses that presented to the Children's Hospital of Los Angeles over a 20 year period. In all, 59 cases of congenital dermal sinuses came to the attention of our service. 35 of these lesions involved the intradural compartment. Of the lesions extending intradurally, 15 involved the cranium. 4 were naso-frontal and 11 were occipital. Of these, 4 presented with infection while 1 presented with neurological deficit.

MRI imaging with gadolinium contrast was obtained in 24 of these cases while CT and myelographic images were obtained in 17. We found that MRI imaging techniques detected CDS in 75% of these cases. CT and myelographic images showed positive results in 59%. False negative MRI images were associated with delay of diagnosis which led in several cases to fulminant infection or neurological deficit.

Results were generally good. Complications included hydrocephalus which required shunting in two children. Permanent neurological deficits occurred in 3 children, all of which were associated with infection.

Congenital dermal sinuses remain a radiographic diagnostic challenge. Diagnosis of these lesions must involve the utilization of a careful physical examination in addition to radiographic techniques.

5. The Reversal Exchange Technique of Total Calvarial Reconstruction for Sagittal Craniosynostosis in Infants

Joseph Fata, MD, Michael S. Turner MD

The role of total calvarial reconstruction in the treatment of sagittal craniosynostosis remains controversial, especially in patients under one year of age. The purpose of this study was to prospectively evaluate the efficacy of a single surgical technique for total calvarial reconstruction (Reversal Exchange Technique) in patients less than one year of age. Twenty three consecutive patients underwent the Reversal Exchange Technique of total calvarial reconstruction at a median age of 3 months (range 6 weeks to 10 months). Quantitative assessment was based on pre-operative and post-operative (minimum 6 months) measurements of the Cephalic Index (cranial width/height $\times 100$) taken from 3-D CT scans which were obtained in 18 of 23 patients. Aesthetic assessment was based on the grading of pre-operative and post-operative photographs (obtained in 17 of 23 patients) by two independent raters blinded to the surgical technique. The mean pre-operative Cephalic Index was 65.0, and the mean post-operative Cephalic Index was 76.4, yielding a mean improvement of 11.4 (17.5%). Photographic evaluation rated normalization of head shape (grade 4) in 11 of 17 patients (64.7%) and minor residual deformities (grade 3) in 6 of 17 patients (35.3%). No patients were identified with significant residual deformities (grades 1 or 2). There were two intra-operative and one post-operative complication, none of which had permanent sequelae. We conclude that the Reversal Exchange Technique of total calvarial reconstruction provided significant improvement in head shape based on quantitative measurements (Cephalic Indices) and independent evaluation of aesthetic improvement with an acceptable complication rate.

6. Changes in Ankle Spasticity and Strength as a Result of Selective Dorsal Rhizotomy

Jack R. Engsborg, PhD, Sandy A. Ross, MHS, Kenneth S. Olree, MS,
T. S. Park, MD (*St. Louis, MO*)

Selective dorsal rhizotomy (SDR) is performed on patients with cerebral palsy to minimize or eliminate the influence of spasticity. A limitation associated with the surgery is muscle weakness. This investigation quantified changes in plantarflexor spasticity (i.e., velocity dependent resistance to passive stretch) and maximum active joint torques as a function of SDR surgery. Twenty patients with spastic diplegic cerebral palsy (CP group) undergoing SDR were tested the day prior, and approximately 8 months post-surgery. Twelve volunteers with able bodies (AB controls) made up a control group. For the spasticity measure, a dynamometer extended the passive ankle through a range of motion at speeds of 10, 30, 60, 90, and 120°/s while monitoring the resistive torque from the ankle plantarflexors. For the active torque measure, the machine plantarflexed the ankle at 10°/s while the patient performed a maximum concentric contraction of the plantarflexors. Work values for the torque-angle data were calculated for each speed and patient. For the spasticity measure, linear regression was used to derive the slope of the line of best fit for the work-velocity data. Work by the plantarflexors was used for the strength measure. T-tests were employed for detecting significant differences ($p < 0.05$). Pre-surgery, the plantarflexor spasticity in the CP group ($0.0259 \text{ J}/(^{\circ}/\text{s})$, $\text{SD}=0.0263$) was significantly greater than that of the AB controls ($0.0062 \text{ J}/(^{\circ}/\text{s})$, $\text{SD}=0.0038$). Post-surgery values ($0.0129 \text{ J}/(^{\circ}/\text{s})$, $\text{SD}=0.0158$) were significantly less than pre-surgery values and not significantly different than AB controls. Post-surgery values for maximum plantarflexion work of the plantarflexors ($0.27 \text{ J}/\text{kg}$, $\text{SD}=0.20$) were not significantly different from pre-surgery values ($0.18 \text{ J}/\text{kg}$, $\text{SD}=0.21$), and both pre- and post-surgery work values were significantly less than similar values for the AB controls ($0.92 \text{ J}/\text{kg}$, $\text{SD}=0.42$). It was concluded that SDR with post-surgery physical therapy reduced spasticity and did not alter the ability to do work in the plantarflexors. The first conclusion is supported by the literature, while the second is not. Results from a few individuals support literature stating that care must be taken in selecting patients for SDR. These methods could aid in the process.

7. Does the Amount of Rootlet Sectioning in Selective Dorsal Rhizotomy Correlate to the Improvement in Spasticity at That Level?

Toru Fukuhara, MD, Imad M. Najm, MD, Kerry Levin, MD,
Mark G. Luciano, MD, PhD (*Cleveland, OH*)

Objective: Although the number of rootlets sectioned during a selective dorsal rhizotomy (SDR) varies widely between centers, patients and spinal level, the relationship between the percentage cut and the change in muscle tone or range of motion (ROM) at specific levels has not been studied. This study examines the correlation between rootlets sectioned and decreased tone or ROM improvement.

Methods: Thirty-four children with cerebral palsy (M 23, F11) who underwent SDR over two years were studied. Nerve rootlets were transected according to modification of the Fasano criteria. Muscle tone (Ashworth scale) and ROM were examined pre- and post-operatively and related to the percentage of rootlets cut at each level. The correlation between the transected amount at each level and improvement of Ashworth score or ROM was analyzed statistically with Spearman rank correlation tests.

Results: Significant positive correlation was obtained between the degree of L2 sectioning and hip adductors ($r=0.46$, $p=0.047$), L3 and quadriceps ($r=0.49$, $p=0.039$), S1 and hamstrings ($r=0.47$, $p=0.017$) and plantar flexors ($r=0.46$, $p=0.021$). The ROM of ankle dorsiflexion significantly correlated to S1 sectioning ($r=0.42$, $p=0.043$). No correlation was observed for hip abduction, Thomas test, straight leg raising or popliteal angle to any root levels.

Conclusion: The amount of nerve root sectioning at each level does specifically relate to a decrease in tone at that level. Therefore, specific knowledge of the preoperative clinical status may be useful in guiding the degree of sectioning during SDR.

8. Nonselective Partial Dorsal Rhizotomy: A Clinical Study With One Year Follow Up*

David Sacco, MD, Chester Tylkowski, MD, Benjamin Warf, MD
(Lexington, KY)

Introduction: The ability to perform a “selective” dorsal rhizotomy has been challenged. EMG responses are inconsistent and often do not represent reflex responses. We perform Nonselective Partial Dorsal Rhizotomy (NSPDR) when reflex response is not evident. One-year follow up of 10 children primarily undergoing NSPDR is presented.

Methods: Ten children underwent NSPDR. They were evaluated preoperatively and post-operatively with the Modified Ashworth Scale, gait lab analysis, and the GMFM. Scores were compared using the paired t test. NSPDR was performed by non-selectively sectioning 50 – 75% of the fibers of the dorsal roots not demonstrating a reflex response. Standard “selective” rhizotomy was performed in the remainder.

Results: Only 17 of 106 (16%) dorsal roots demonstrated reflex responses. The Modified Ashworth Scale revealed a statistically significant decrease in spasticity of the adductors ($P < .0002$), hamstrings ($P < .0199$), quadriceps ($P < .0368$), and plantarflexion ($P < .0004$). Gait lab analysis revealed a statistically significant increase in stride length ($P < .0084$). Range of motion increased for hip and knee flexion and extension. The GMFM for walking running and jumping improved 9.2%.

Discussion: Statistically significant improvements in spasticity and stride length were evident. Total GMFM score analysis for the entire group is not available due to omission of dimensions in a few patients. Improvement in the walking, running and jumping dimension of the GMFM was statistically significant and comparable to recent studies.

Conclusion: NSPDR is an effective treatment for spasticity in patients with cerebral palsy. A prospective randomized trial would be necessary to compare the efficacy of this technique to “selective” partial dorsal rhizotomy.

**Considered for Shulman Award*

9. Mid-thoracic Catheter Tip Placement for Baclofen Administration in Children with Quadriparetic Spasticity

Paul Grabb, MD, Amy Pittman, RN, Sharon Renfroe, RN, Jay Meythaler, MD
(Birmingham, AL)

Purpose: In an effort to increase the effect of intrathecal baclofen upon upper extremity spasticity the tip of the intrathecal catheter was placed at the T6-7 level rather than at the traditional T11-12 level in children with spastic quadriparesis.

Methods: Twelve children with spastic quadriparesis underwent placement of a programmable pump and intrathecal catheter tip placed at the T6-7 level. Degrees of spasticity using the Ashworth scale for 4 muscle groups in both the upper and lower extremities were recorded preoperatively and at 1 and 3 months postoperatively. A Wilcoxon signed-rank test determined the significance of differences between the preoperative and 3-month-postoperative Ashworth scores. Changes in upper and lower extremity Ashworth scores for the entire cohort were compared to published results where the catheter tip had been placed at the T11-12 level.

Results: Spasticity was significantly reduced in all muscle groups (P less than 0.001). The reduction in lower extremity spasticity (1.6 points) at 3 months was very similar to the published results at 3 months (1.4 points). The reduction in upper extremity spasticity was noticeably greater at 3 months (1.7 points) than published results at 3 months (0.4 points) and at 12 months (0.6 points). There were no complications related either to the positioning of the catheter or to the administration of baclofen at the T6-7 level.

Conclusion: Placement of the tip of the intrathecal catheter at the T6-7 level was associated with greater relief of upper extremity spasticity without loss of effect upon the lower extremities compared to published results with a T11-12 catheter tip placement.

10. Subfascial Placement of Baclofen Pumps

Paul Grabb, MD, Amy Pittman, RN (*Birmingham, AL*)

Purpose: To reduce tension on the abdominal incision and achieve better wound healing in small children, baclofen pumps were placed under the rectus fascia rather than superficial to the fascia.

Methods: Twenty-two children underwent placement of a full-sized baclofen pump for quadriparetic spasticity. Sixteen children (mean 28.3 kg) had suprafascial placement of the pump. Six children (mean 18.0 kg) had placement of the pump directly atop the rectus abdominus and oblique muscles through a subfascial approach. The fascia was then closed over top the pump. The quality of healing was recorded at last follow-up.

Results: There were two infections in two children within 60 days of suprafascial pump placements. One child developed an infection when a pressure sore developed over the pump 10 months after suprafascial pump placement. There were no operative complications in the children with pumps in the subfascial space. All children less than 20 kg with a suprafascial pump placement had spreading of the healing incision. The group with subfascial pump placement had no incisional spreading. There was no increased difficulty in percutaneously accessing the pumps placed subfascially. Subfascial pumps ranged from almost undetectable to moderately noticeable by visual inspection. The suprafascial pumps resulted in unsightly bulges, even in children up to 40 kg.

Conclusion: Subfascial pump placement results in better incisional healing because of less tension and a cosmetically superior appearance. Because of improved healing the infection rate may be lower with subfascial placement.

11. Implantation of Medulloblastoma Cells into Collagen Type I Gels: Invasiveness, Enzymatic Characterization and the Impact of Surgical Excision and Radiation*

Adrianna Ranger, MD, Warren McDonald, BSc, MLT, Emi Moore, BSc, MLT, Rolando F. DelMaestro, MD, PhD, FRCS (C) (*London, Ont*)

Objectives: Despite improvements in treatment, local recurrence continues to limit the survival of medulloblastoma patients. Recurrence is related to the presence of residual invasive cells and failure to control these cells continues to limit progress. The objectives of the study were to 1) obtain quantitative data on the invasiveness of medulloblastoma cell lines in a three dimensional model, 2) characterize the mechanism of invasion, 3) examine the influence of surgical removal on residual invading cells, and 4) to determine the impact of radiation.

Methods: Five human medulloblastoma cell lines (DAOY, UW 228-1, UW 228-2, UW 228-3 and Madsen) were used to produce tumor cell aggregates which were implanted into collagen Type I gels. Invasiveness was assessed over 5 days. Protease enzyme assays and specific protease inhibitors were used to assess invasive mechanisms. The central tumor mass was excised and the invasiveness of the residual cells monitored. Invasive behavior after single doses (0 Gy - 25 Gy) and fractionated doses (0 Gy - 24 Gy total) of radiation was measured.

Results: Cell line doubling times (28-60 hours) showed no correlation with invasive behavior. In four cell lines, individual tumor cells detached from the surface of the cell aggregates and invaded the gel for distances of 800-1200 μm at rates of 50-300 $\mu\text{m}/\text{day}$. A dose-related decrease in invasive behavior was seen in response to metalloprotease and cysteine protease inhibitors. Tumor mass excision had no significant influence on the invasiveness of residual cells. Tumor cell aggregates retained invasive capacity after radiation, but showed a dose-dependent reduction in invasive behavior.

Conclusions: Excision and radiation had little impact on medulloblastoma cell invasiveness in the 3 dimensional model studied. Invasion depended on metalloprotease and cysteine protease activity. These inhibition studies suggest therapeutic implications and warrant clinical assessment.

**Considered for Shulman Award*

12. Bone Morphogenetic Proteins 2 and 4 Attenuate Apoptosis in a Cerebellar Primitive Neuroectodermal Tumor Cell Line*

Mark Iantosca, Clifton E. McPherson, PhD, Shih-Yieh Ho, PhD,
Gerald D. Maxwell, PhD (*Farmington, CT*)

Objective: Similarities between primitive neuroectodermal tumors (PNET) and CNS progenitor cells have evoked interest in the response of these tumors to endogenous growth factors. The bone morphogenetic proteins (BMPs) have recently been found to regulate survival and differentiation of CNS progenitor cell populations. This study investigated the effects of BMP-2, 4 and 6 on a cerebellar PNET (PNET-MB) cell line.

Method: The undifferentiated PNET-MB cell line DAOY was cultured in the presence and absence of BMP-2, 4 and 6 for 72 hours. Resulting specimens were analyzed for total cell counts, proliferating cell nuclear antigen (PCNA), and apoptotic DNA fragmentation. Expression of BMP receptors was examined by reverse transcriptase-polymerase chain reaction (RT-PCR).

Results: A significant increase in total cell count was noted in the BMP-2 and BMP-4 groups, without significant differences in PCNA reactivity. Immunohistochemical analysis for apoptotic DNA fragmentation demonstrated a dramatic decrease in the proportion of apoptotic nuclei in cultures treated with BMP-2 and 4 at concentrations above 5ng/ml ($P < 0.001$). These effects were not observed with BMP-6, TGF- β 1 or GDNF. Expression of transcripts for the BMPR-IB, BMPR-II, and ActivinR-I receptors was increased with BMP-2 treatment.

Conclusion: These observations suggest that an attenuation of apoptosis by BMP-2 and 4 results in increased total cell number in this tumor. The anti-apoptotic effect of BMP-2 and BMP-4 on this cell line has potential clinical implications for neuroectodermal tumors.

**Considered for Shulman Award*

13. Growth Regulated Oncogene in Oligodendrogliomas: Constitutive Activation of a Proliferative Pathway Used during Development

Shenandoah Robinson, MD, Joel Levine, PhD (*Syracuse, NY*), Mark Cohen, MD (*Cleveland, OH*), Robert H. Miller, PhD (*Cleveland, OH*)

Gliomas may arise from proliferative pathways used during development that become inappropriately activated. Recently, we showed that a paracrine pathway regulates oligodendrocyte precursor proliferation in the developing rat spinal cord. Growth regulated oncogene (GRO-a) produced by astrocytes amplifies platelet-derived growth factor (PDGF-AA)-induced oligodendrocyte precursor proliferation. Oligodendrocyte precursors express GRO-a and PDGF receptors, but not GRO-a or PDGF. This precise mechanism for regulating oligodendrocyte precursor cell number during development may be disrupted in oligodendrogliomas, resulting in unchecked precursor proliferation. Methods: Immunohistochemistry for NG-2, a proteoglycan expressed by oligodendrocyte precursors, was used to differentiate oligodendrogliomas from other tumors. Specimens were also labeled with GRO-a, GRO-a receptor, PDGFaR, and GFAP. Vibratome sections were incubated with primary antibody, biotin-conjugated secondary antibody, and visualized diaminobenzadine. Staining patterns for each antibody for each tumor were quantified, and results were compared with the neuropathologic diagnosis. Results: Specimens were from three oligodendrogliomas, five astrocytomas, an ependymoma, and a schwannoma. NG-2 labeling was observed only in oligodendrogliomas, which suggests NG-2 can distinguish oligodendrogliomas from other tumors. GRO-a, GRO-a receptor, and PDGFaR staining was moderate to heavy in oligodendrogliomas, but absent in other tumors. In oligodendrogliomas the GRO-a antibody labeled both astrocytes and oligodendrocytes. These data suggest that the GRO-a/PDGF regulatory pathway may have become constitutively active. Conclusions: In this study, NG-2 antibody specifically labeled oligodendrogliomas, and immunohistochemistry suggested a mechanism for uncontrolled oligodendrocyte precursor proliferation. Understanding oligodendrocyte precursor proliferation during development markedly enhances our ability to treat oligodendrogliomas by allowing direct targeting of aberrant signaling mechanisms.

14. In Vitro Model for Treatment of Disseminated Neoplastic Processes*

Florence Barnett, MD[†], James Fick, MD (*Augusta, GA*)

Introduction: Cerebrospinal fluid dissemination of neoplastic processes such as medulloblastoma imparts a therapeutic challenge and frequently a dismal prognosis. In order to create a more clinically relevant in vitro model for treatment of disseminated neoplastic processes, we have cultured, transduced and treated commercially available primitive neuroectodermal tumors using CSF as a medium.

Methods: Commercially available PNET cell lines including DAOY and PFSK were cultured in human CSF obtained from patients with brain tumors in 24 well plates. Subsequently, fibroblasts with retroviral vectors (STK, VPC) or an adeno-associated viral vector (multiplicity of infection_MOI 10 to 5th) was used to condition CSF over a period of 72 hours to effect transduction with Herpes Simplex Virus thymidine kinase gene imparting sensitivity to the antiviral agent ganciclovir. Cell cultures were treated with ganciclovir at 2.5uM concentration - attainable CSF concentration with intravenous administration at recommended clinical dose - in fresh CSF. Cell counts were performed over a period of ten days.

Results: The PNET cell lines demonstrated survival in selectable media and dose response to ganciclovir consistent with the CSF concentration attainable via intravenous administration. Cell counts over a period of ten days revealed an up to 99% kill of transduced cells.

Conclusion: This signifies the ability to achieve transduction in a physiologic medium and a possible approach to treatment of disseminated neoplastic processes.

**Considered for Shulman Award*

†Disclosure Information

15. Growth Kinetics of Pediatric Low Grade Gliomas

Jorge Lazareff, MD, Rafal Suwinski, MD, PhD, Roberto De Rosa, MD,
Charles Olmstead, PhD

Pediatric low grade gliomas (PLGG) represent a formidable challenge for the neuro oncology team. These tumors can not be always resected completely and based on reports of PLGG quiescent growth, radiological and clinical follow up is considered an alternative to active adjuvant therapy for remnant PLGG. The analysis of growth kinetics of these tumors could be helpful for understanding the biological behavior of PLGG. We identified six children with hypothalamic chiasmatic PLGG and one with a mesencephalic PLGG, five of these patients were treated only with biopsy and two with partial tumor resection. All of seven patients had 10 to 15 sequential brain MRI over a time span of 3 to 8 years. The MRI were scanned and tumor volume was determined using a SigmaScan Image® software. In four patients whose tumor volume was approximately 100 cc at the time of diagnosis, slow spontaneous partial regression was observed. In three other patients decelerating regrowth of the tumor was observed and the pattern of growth of these three tumors was best described by the Gompertz equation, predicting a plateau in tumor growth at about 100 cc. These results suggest that growth of PLGG decelerates as tumor becomes large and that partial spontaneous regressions of PLGG are not uncommon. An analysis of the growth kinetics of PLGG can help in creating the rational basis for choice between an active adjuvant therapy or a conservative follow up.

16. Post-Treatment Choline Signal Intensity in Pediatric Gliomas

Jorge Lazareff, MD, Rakesh Gupta, MD, Jaime Nieto, MD, Jeffrey Alger, PhD

Pediatric brain gliomas are not always amenable for complete surgical excision, therefore adjuvant treatment for a large tumor mass is often required. As tumor volume shrinkage may not be a reliable method for assessing response to treatment, information about the tumor growth potential is desirable for an adequate follow up of the patients. Choline (Cho) signal intensity, determined by proton magnetic resonance spectroscopy imaging (H-MRSI), have proved to be a reliable indicator of the metabolic activity and of tumor progression in various intracranial tumors. In this study we have sought to determine if H-MRSI can be of use in monitoring the response of pediatric gliomas to different forms of therapy. We performed pretreatment and post treatment H-MRSI in 11 children with biopsed or partially excised brain gliomas, 42 H-MRSI along 2 to 38 months. 10 patients had chemotherapy or radiotherapy 1 had surgery only. As an indicator of tumor activity we utilized the ratio between tumor/brain Cho signal intensity. Treatment response was determined by tumor volume and tumor doubling time. In 7 patients whose tumor volume decreased or remained stable we observed that the Cho ratio decreased ($p < 0.01$) after treatment and remained low during longitudinal follow up. In 4 patients whose tumors progressed the Cho ratio increased after treatment. In all patients there was a significant correlation between tumor doubling time and pre and posttreatment Cho (Spearman $r = 0.72$, $p < 0.002$). Our results suggest that H-MRSI can provide complementary information about growth potential of pediatric gliomas.

17. Second Brain Tumors Following Radiation and Chemotherapy*

C. L. Bonasso, MD, D. Bouc', MD, E. Kosnik, MD (*Columbus, OH*)

To study secondary brain tumors in the pediatric, population patients with a history of a brain tumor treated by resection and radiation and followed by occurrence of a second brain neoplasm were identified in the tumor registry. Seven patients were identified: a 1 year old female with a medulloblastoma and secondary meningeal sarcoma; a 3 year old male with a grade II cerebellar astrocytoma and secondary right temporal high grade glioma; a nine year old male with a medulloblastoma and secondary glioblastoma; a seven year old male with a craniopharyngioma and secondary brainstem and thalamic gliomas; a five year old male with a medulloblastoma and a secondary glioblastoma; an eleven year old female with an astrocytoma and a secondary meningioma; a sixteen year old male with a grade 2-3 astrocytoma and a secondary meningioma. The records were examined for pathology of primary tumor, pathology of secondary tumor, amount of radiation administered, tumor latency, and age at initial presentation. The mean age at presentation was 6.2 years; mean tumor latency was 15 years; mean radiation dose was 4600 cGy. Three patients had chemotherapy with varying regimens and duration of therapy. The study findings indicate that the secondary brain tumors of these patients were likely caused by irradiation. Our findings support current trends in pediatric neuro-oncology to focus irradiation and forego irradiation for benign brain tumors. Molecular biological evaluation of these primary and secondary tumors is ongoing at our institution.

**Considered for Shulman Award*

18. Focal Tectal Lesions in Late-Onset Aqueductal Stenosis in Children

Nejat Akalan, MD, Ergün Daglioglu, MD, Aysenur Cila, MD
(Ankara, Turkey)

Objective: Improvements in neuroimaging techniques allow to delineate a distinct group of children with various tectal lesions manifested with aqueductal stenosis. Our aim is to document the incidence, characteristics and outcome of tectal lesions in previously shunted children.

Methods: A retrospective analysis was performed on 14 patients who were treated between January 1987 and September 1997 with the diagnosis of late on-set aqueductal stenosis.

Results: Out of 137 cases of aqueductal stenosis cases treated during a 10 year period, 18 (13,1%) were recognized as late-onset cases with the age at presentation being over 4 years. Fourteen (77,8%) out of 18 whom demonstrated tectal lesions on MR studies were taken into consideration for this study. Their ages ranged from 4 to 15 years at presentation (median 8 years). All cases presented with symptoms of increased intracranial pressure. Symptom duration was less than 8 months. All cases had CT studies initially with no abnormality other than hydrocephalus and underwent ventriculoperitoneal shunt insertion for treatment. MRI studies during follow-up revealed periaqueductal or tectal lesions reported as tumor in all but one by neuroradiologists. Median follow-up was 4,2 years and none of these lesions exhibited any change in lesion characteristics. No patient showed evidence of disease progression due to tectal lesion. Five (35,7%) cases were reoperated for shunt dysfunction or complications due to over-drainage.

Conclusion: Although classified as focal tumors, tectal lesions in late-onset aqueductal stenosis hardly ever show progression. Such cases do not require adjuvant therapy and can be managed safely by CSF diversion with MRI follow-up.

19. Impact of Surgical Shunting on Neurometabolic Development of Hydrocephalic Children: A Longitudinal Study with Quantitative Magnetic Resonance Spectroscopy**†

Stefan Bluml, PhD[†], Jeannie Tan, BS, Kay J. Seymour, PhD, Jung-Hee Hwang, PhD, Robert S. Pudenz, MD, J. Gordon McComb, MD, Brian D. Ross, MD, PhD
(Pasadena, CA)

Objectives: 1. Monitor changes during normal human brain development, using quantitative in vivo 1H MRS, proton-decoupled 31P MRS (QMRS) and MR-image segmentation. 2. Define the long-term impact of hydrocephalus (Hc) and shunt surgery (SS) on brain and csf-volume and on neuro-metabolic development, by QMRS.

Patients and Methods: 20 Hc and SS (0.03-39yr) and 12 normal controls (0.02-33yr). 65 QMRS exams (116 spectra) to determine cerebral metabolites (mmol/kg brain) and brain water; MRI-segmentation of CSF and brain tissue volumes, were performed on a GE 1.5T Clinical MR scanner.

Results: Csf volume, increased in Hc, fell significantly ($0.28 \text{ liters} \pm 0.16$ vs 0.16 ± 0.13 ; $P < 0.003$, $N=8$ in paired t-test) after SS. Brain water was normal for age in Hc and SS. QMRS was normal in untreated Hc, and followed normal developmental curves after SS (longest follow-up 32 years). One child (Hc-QMRS normal), showed significant reductions in N-acetylaspartate, glycerophosphorylcholine and -ethanolamine after SS, QMRS features consistent with a neurometabolic disorder and neurodevelopmental delay unrelated to SS.

Discussion: In contrast to animal models, in human infants, Hc does not alter brain water, neuronal marker(s), cerebral osmolytes, myelin-membrane composition or energy metabolism, all of which remain normal after SS. QMRS can identify other causes of neurodevelopmental delay.

Conclusion: In well-treated Hc, neuro-metabolic development is normal.

**Considered for Shulman Award*

†Considered for Hydrocephalus Award

†Disclosure Information

20. Endoscopic Approach to Non-communicating Fluid Spaces in the Shunted Patient**

Bakhtiar Yamini, MD, Liliana C. Goumnerova, MD (*Boston, MA*),
David M. Frim, MD, PhD (*Chicago, IL*)

Introduction: It is well known that shunted patients can, over time, develop entrapped ventricles or cystic spaces not in communication with the remaining ventricles. This situation has traditionally been treated with placement of an additional catheter or shunt system in the non-communicating fluid space. With the advent of minimally invasive endoscopic techniques, it has become possible to fenestrate trapped fluid spaces into the shunted ventricular system, thus preventing the need for additional catheters.

Methods: Fifteen shunted patients presented with non-communicating fluid spaces over a 4 year period at our two institutions. We were able to perform 17 fenestration procedures in 14 of those patients. The various procedures were: septum pellucidum fenestration (n=8), cyst fenestration (n=7), third ventriculocisternostomy (n=2).

Results: Thirteen of 17 (76%) endoscopic fenestrations successfully prevented a complicated shunting system. There were 4 technical failures (4/17, 24%) in which an additional catheter was added to the existing shunt system. There were no adverse neurologic effects from the endoscopic procedures; however, in 4 of the cases (4/17, 24%) a shunt revision was performed between 2 and 30 days following the fenestration.

Conclusions: These results show that the endoscopic approach to establishing communication between non-communicating CSF spaces in the shunted patient is safe and efficacious in preventing the need for additional CSF catheters. Though we encountered failures, the majority of cases are technically feasible. Care must be taken, however, as a significant number of fenestrated patients will experience early shunt malfunction.

21. In Vitro Detection of Fluid Flow in Ventriculoperitoneal Shunts (VPS) Using Contrast Enhanced Ultrasound**

Dan Lieberman, MD[†], Steven Lester, MD, Martin Holland, MD,
Michael Wood, Claude Hemphill, MD, Istvan Matej, Grant Gauger, MD
(*San Francisco, CA*)

In theory ultrasound may provide a real-time measure of cerebrospinal fluid (CSF) flow through a VPS. However, up to half of pediatric shunts do not carry the particulate matter -such as ependymal cells or choroid plexus debris- necessary to reflect sound waves essential for CSF flow measurement. Microspheres of human serum albumin with octafluoropropane (Optison) administered by intravenous infusion are now used as contrast agents for the study of cardiac structure and function using ultrasound. We examined the ultrasound signal of (i) saline alone; (ii) agitated saline; or (iii) Optison within VPS tubing after injection into a VPS reservoir to determine the potential of these agents to enhance the ultrasound signal. A constant flow of artificial CSF was established through a VPS (Codman Unishunt) using a syringe infusion pump (Harvard Apparatus). To simulate the subcutaneous portion of a VPS the distal end of the tubing was tunneled 3 mm below the surface of an ultrasound gel pad (Aquaflex, Parker Labs). With the pump flowing at 30 ml / hour 0.2 ml of saline, agitated saline, or Optison were injected into the reservoir while insonating the shunt catheter using two dimensional ultrasound. The inner and outer lumens of the shunt tube were well visualized. After injection of agitated saline or Optison micro-bubbles were clearly seen in the shunt. Enhancement of the ultrasound signal was greatest with Optison.

Flow through a VPS may be clearly and consistently imaged using ultrasound after injection of echogenic microspheres into the reservoir. A ultrasound video image of contrast enhancement of flow will be shown. Prior work has established the capacity of ultrasound to measure CSF flow within VPS in which there is sufficient endogenous contrast. Contrast enhanced echocardiography may permit reproducible and reliable measurements of flow volume and rate in a VPS, with material application to the study of shunt function or failure.

**Considered for Shulman Award*

†Considered for Hydrocephalus Award

‡Disclosure Information

22. Cerebral Pseudoaneurysm Rupture and Hemiplegia Following Thermocoagulation of Proximal Catheter During Shunt Revision

Azedine Medhkour, MD, W. Bruce Cherny, MD, C.A. James, MD
(Little Rock, AR)

Objective and Importance: Thermocoagulation of adherent proximal catheters during shunt revision is a widely utilized technique aimed at reducing the risk of intraventricular hemorrhage. Complications of this technique have not been previously reported to our knowledge.

Clinical Presentation: Two patients sustained new neurological injury after employing this technique. A six year old male with an interhemispheric cyst suffered an intraventricular hemorrhage and shunt obstruction two weeks after an uneventful proximal shunt revision. An initial angiogram failed to reveal a vascular etiology. After a second hemorrhage, repeat angiography demonstrated a pseudoaneurysm of the frontopolar branch of the anterior cerebral artery. Attempted embolization failed and he required surgical excision. Review of the pre-hemorrhage CT scan showed the tip of the catheter positioned in proximity to the anterior cerebral artery.

The second patient is an 18 year old female who presented with abraded skin and scalp cellulitis over her shunt after an altercation. The shunt remained functional and was not infected. Despite two courses of intravenous antibiotics the infection persisted requiring entire shunt removal and temporary ventricular drainage. Her proximal catheter had not been revised for many years and was very adherent. The course of her proximal catheter ran adjacent to the internal capsule. Post-operatively she was hemiplegic. She has made a significant recovery but remains impaired 18 months later.

Conclusion: These two complications demonstrate that although intraluminal thermocoagulation remains an attractive technique, it is not without risk. The generated heat can seriously injure sensitive adjacent tissues resulting in significant neurological sequelae.

23. Percutaneous Endoscopic Shunt Recanalization—Long Term Results in 20 Cases

Jogi Pattisapu, MD[†], Eric Trumble, MD, Kay Taylor, RN, Denise Howard, CT, Tina Kovacs, RN

Introduction: Proximal ventricular catheter obstruction by choroid plexus is a frequent occurrence in children with shunted hydrocephalus. In some cases, the flow is obstructed due to membranous occlusion by a small amount of tissue. It has been shown that only a few of the multiple catheter openings need be patent to maintain adequate shunt function. Recent advances in technology have improved our ability to perform intraluminal endoscopic catheter dissection and minimize the morbidity associated with shunt maintenance.

Methods: Twenty cases (18 children) of percutaneous endoscopic shunt recanalization were performed under IRB study protocol. The mean age was 32 months, and all children had signs and symptoms of shunt malfunction, confirmed by CT/MRI and verified by shunt taps. Under aseptic conditions in the operating room, the Rickham reservoir was entered with a 16g angiocath and the obstruction was visualized with a fiber endoscope (0.5 - 0.8mm). Intraluminal dissection using electrocautery was performed with endoscopic guidance to visualize the catheter openings and free flow of CSF was established. Adequate distal flow was confirmed by occluding the ventricular catheter and flushing the valve.

Results: At 11.4 month mean follow-up (range 7-18 months), the children are doing well with CT/MRI confirmation of adequate ventricular decompression in the 17 successful cases. There were 3 failures in this study, necessitating a standard open shunt revision.

Conclusion: The percutaneous endoscopic shunt recanalization procedure can be used successfully to treat proximal shunt malfunction.

[†]*Disclosure Information*

24. Treatment of Cerebrospinal Fluid Shunt Infections**

William E. Snyder, Jr., MD, Joel C. Boaz, MD, Abdolreza Siadati, MD,
John E. Kalsbeck, MD, Thomas G. Luerssen, MD, Martin P. Kleiman, MD
(Indianapolis, IN)

Objective: To evaluate our experience in treating CSF shunt infections in order to identify treatment strategies that swiftly eradicate infections.

Methods: Retrospective review of CSF shunt infections treated at a Children's Hospital from January 1, 1991 to December 31, 1995.

Results: 119 infections were treated. Symptoms included shunt malfunction in 74 (62.2%), fever in 58 (48.7%), abdominal pain in 28 (23.5%), and wound breakdown, swelling, or erythema in 38 (31.9%). Coagulase negative staphylococcus was the primary organism in 42 cases (35.6%), staphylococcus aureus in 23 (19.3%), propionobacter acnes in 17 (14.3%), gram negative rods in 22 (18.5%), and other gram positive organisms in 15 (12.6%). Intravenous antibiotics tailored to the organism were used in all cases. Immediate externalization of the shunt was performed in 86 cases (72.3%). However, removal of the externalized shunt with ventriculostomy placement was required to clear the infection in 55.8% of these cases. This was especially true with coagulase negative staphylococcus and staphylococcus aureus shunt infections where 65.5% and 70.6% respectively required complete removal of the shunt system. Propionobacter acnes infection required removal of the externalized shunt with ventriculostomy placement in only 13.3%. New shunts were placed after the CSF was sterile after an average of 13.3 days, and antibiotics were continued an average of 9.5 days after shunt replacement. Five shunts became "reinfected" in the postoperative period, yielding a failure rate of 4.2% with this treatment protocol.

Conclusions: Treatment of shunt infections using immediate externalization, with rapid conversion to ventriculostomies if the CSF remains infected, and a three week course of intravenous antibiotics effectively eradicated the infections. While this approach seems aggressive compared to other reported therapies, we were able to achieve a "reinfection" rate essentially equal to the institutional infection rate for newly placed shunts.

*Considered for Shulman Award

†Considered for Hydrocephalus Award

25. Coccygeal Pits*

Bradley Weprin, MD, W. Jerry Oakes, MD (*Birmingham, AL*)

Introduction: Congenital dermal sinuses represent cutaneous depressions or tracts that are lined by stratified squamous epithelium. They communicate between the surface of the skin and deeper structures and may occur anywhere along the craniospinal axis. They may often be accompanied by other cutaneous stigmata, various dysraphic abnormalities, or intraspinal tumors.

In the sacrococcygeal area cutaneous congenital abnormalities are relatively common occurring in 2-4% of the neonatal population. These intergluteal depressions in the perianal region are frequently referred to as pits or dimples. Their etiology is considered similar to other congenital dermal sinuses and appears unrelated to acquired pilonidal conditions observed in adults.

Controversy regarding the evaluation and management of cutaneous defects in the coccygeal region exists.

Methods: Databases for articles published in English were surveyed for key words relating to coccygeal sinuses using standard computerized search techniques. The medical records of children presenting to our neurosurgical clinic for evaluation of dorsal dermal sinuses were reviewed to identify those with intergluteal skin abnormalities.

Results: In the evaluation of reported cases and of our own, we were unable to identify any infants with coccygeal pits with surgically significant intradural pathology or connections.

Conclusions: Intergluteal coccygeal pits are common lesions that frequently come to neurosurgical attention. They do not appear to be associated with significant risk of spinal cord and intraspinal anomalies. Simple intergluteal coccygeal pits without other cutaneous findings do not require radiographic or surgical evaluation and treatment. If other markers or neurologic symptoms are present, however, radiographic evaluation may be indicated.

26. Anorectal Malformations and Spinal Dysraphism

Robert Keating, MD, C.M. Shaer, D.W. Pincus, L.J. Haga, K. Newman,
P.H. Cogen (*Washington, DC*)

The association between anorectal anomalies and intraspinal pathology has long been recognized by clinicians. Nevertheless, there remains uncertainty as to the overall incidence of a tethered cord in this setting, association with the degree of malformation severity, as well as the long-term outcome of these children undergoing tethered cord release and the likelihood of retether. In an attempt to answer these questions, we reviewed our neurosurgical experience at the Children's National Medical Center over the past 11 years.

The clinical course of 54 patients with anorectal anomalies was reviewed with respect to the severity of malformation and association of a tethered cord. Sixteen patients (8 males, 8 females) were identified with tethered cords (30%) requiring surgery. The average age at tethered cord release was 1.6 (0.5-4) years with an average follow-up of 2.7 (0.5-10) years (3 patients were lost to follow-up). Ten patients had high lesions, whereas 6 patients presented with low lesions. Two patients had subsequent surgery for retether 2 years after their initial surgery and one patient had two separate areas of tethering. In addition, one patient presented initially with a small filum lipoma and normal positioned conus who was seen within one year to have a significant increase in the size of the lipoma as well as early signs of tethering.

All children with anorectal malformations now routinely undergo entire craniospinal evaluation and are followed postoperatively through their growth curves for possible rethethering. Furthermore, there may be a significant value in performing a prophylactic tethered cord release in the patient with a normal positioned conus and filum fibrolipoma in the setting of anorectal anomalies.

27. Analysis of 42 Patients Operated Upon for Lumbosacral Lipoma*

Jeffrey Lee, MD, Warwick J. Peacock, MD (*San Francisco, CA*)

Introduction: Children born with lumbosacral lipomas tend to develop neurologic deficits. Some suggest that there is a high complication rate associated with untethering procedures. Hoffman reported deterioration in 16 of 24 patients with lumbosacral lipomas who remained untethered.

Methods: Forty-two patients with lumbosacral lipomas who underwent untethering surgery at U.C.L.A. from 5/86 to 6/98 were reviewed. There were 16 males and 26 females. The average age at operation was 7.3 years (range of 0.1 to 25.8 years). The range of follow-up time since surgery was from the most recent operation to 12 years. Two patients were lost to follow-up. Nineteen non-operated lumbosacral lipoma patients presented with an asymptomatic lumbosacral mass. Fifteen non-operated patients presented with lower extremity weakness, incontinence, sensory deficit, or scoliosis. Nine previously operated lumbosacral lipoma patients presented because of deteriorating neurologic symptoms.

Results: Work-up included MRI in all 44 cases. Of the non-operated asymptomatic 19 patients who were subjected to surgery for untethering, 1 was lost to F/U, none deteriorated, and 18 have remained stable and intact. Of the non-operated symptomatic 15 patients, 1 was lost to F/U, 1 improved, 11 ceased to deteriorate, and 2 deteriorated. Of the previously operated upon symptomatic 9 patients, 3 improved, 4 remained stable, and 2 deteriorated. Complications included CSF leak, wound dehiscence, and seizure. There were no deaths.

Conclusion: Operating on patients with lumbosacral lipomas provides a significantly better outcome than leaving them to an almost inevitable neurologic deficit.

28. Tethered Cord Syndrome in Children with the Conus in a Normal Position

Monica C. Wehby-Grant, MD, Patrick S. O'Hollaren, MD,
Colleen D. Phillips, PA-C (*Portland, OR*)

Children with spina bifida occulta who present with signs and symptoms of tethered cord syndrome are often denied surgery because the MRI demonstrates a conus terminating within the normal range. Here we present a series of 14 children with greater than 6 months follow-up from lysis of the filum despite MRI findings of a conus at L2 or above. Of 17 children who underwent surgery, 3 were lost to follow-up after the initial post-op visit. Of the 14 children included in the study, 7 were male and 7 were female. Ages ranged from 2.5 - 10 years (mean 6.6). Surgical criteria were 1) spina bifida occulta, 2) progressive bladder instability, 3) evaluation by urology/nephrology to confirm neurogenic etiology, and 4) one or more of the following: bowel involvement (fecal incontinence/chronic constipation), lower extremity weakness/gait changes, reflex/tone abnormalities, lower extremity sensory disturbances, scoliosis, orthopedic abnormalities/limb length discrepancy or cutaneous stigmata. Eleven of the 14 children showed improvement or resolution of all symptoms, and the remaining 3 children showed improvement or resolution of some symptoms with stability of others. No child had progression of any symptom and there were no surgical complications encountered. When asked if, in retrospect, they would again choose to undergo the procedure, all parents answered affirmatively. Our results indicate that children who meet the criteria for tethered cord syndrome with spina bifida occulta benefit from this low risk procedure.

29. The Effect of Surgery for Diastematomyelia on Neurologic and Urologic Function

Mark Proctor, MD, Stuart Bauer, MD, Michael Scott, MD,
Lilliana Goumnerova, MD, Joseph Madsen, MD, Mary Kelly, RN,
Mary Darbey, RN (*Boston, MA*)

Diastematomyelia is a rare malformation in which a segment of the spinal cord is split longitudinally by a bony or fibrocartilagenous spicule projecting from the vertebral body. Affected patients may have neurologic sequelae as well as voiding difficulties. This paper reviews 15 patients operated on with this condition at Boston Children's Hospital between 1982 and 1997, with pre-operative and post-operative assessment of both neurological status and formal urodynamic studies.

Eleven female and four male patients ranging in age from newborn to 39 years comprise this series. Mean follow-up is >5 years. Ten of the patients presented in infancy, 80% of whom had characteristic skin lesions. All five older patients presented with urinary incontinence. Nine of the ten infants had abnormal neurologic exam, while all five older patients had neurologic abnormality. Post-operatively in the infant group neurologic status improved in 3, remained stable in 3, and worsened in 4. In the older group, 3 improved and 1 worsened after surgery.

Urodynamic studies were performed in all patients. Seventy percent of infants and eighty percent of older patients had pre-operative abnormalities on urodynamics. Postoperative testing revealed that 2 infants improved, 5 had no change and 3 worsened. In the older group, one improved, two had no change and two worsened. However all of the older patients achieved continence after surgery.

Diastematomyelia produces a mostly lower motor neuron neurologic deficit, but both upper and lower motor neuron dysfunction of the urinary system. In contrast to other forms of occult spinal dysraphism, surgery early in life does not seem to afford better results than when the diagnosis is made later in life. However, if left untreated it is likely to progress to upper motor neuron neurologic dysfunction as well as urinary incontinence.

30. New Insights in the Development of the Secondary Neural Tube and Secondary Neural Tube Defects

Timothy George, MD

Introduction: Human secondary neural tube defects (NTD) are closed defects affecting the most caudal aspect of the spinal cord and are the result of abnormal secondary neurulation. Secondary neurulation results in the formation of the secondary neural tube and the process is believed to involve the consolidation of primitive streak mesenchyme, followed by conversion of the mesenchymal cells to neural cells in the embryonic tail. (Schoenwolf & Delong, 1980)

Materials: In order to delineate the exact cells of origin of the secondary neural tube, a fate map was developed of the early tail precursors in the chick using the carbocyanine dye, Dil, in late primitive streak to early tail anlage stage chick embryos.

Results: We show that precursors of the secondary neural tube reside within the remaining caudal neural plate epithelium, not in the regressing primitive streak mesenchyme, and migrate to specific positions within the secondary neural tube. These precursor cells also express early neural markers indicating that they are of neural origin. Furthermore, antisense oligonucleotide targeting Pax3 can lead to defects of both the primary and secondary neural tube. (George & McLone, 1995)

Conclusions: These findings suggest that development of all spinal cord elements originate from similar neural precursors and that the mechanistically different processes of primary and secondary neurulation may be under similar developmental regulatory controls. Therefore, factors which cause secondary NTD in humans may be similar to factors that lead to defects of the primary caudal neural tube.

31. Clustering of Neural Tube Defects by Location Along the Rostrocaudal Axis-Genetic Implications

Timothy George, MD, Marcy C. Speer, PhD (*Durham, NC*),
Herbert E. Fuchs, MD, PhD (*Durham, NC*), and the NTD Collaborative
Group

Introduction: Recent experimental embryological models have suggested that the morphology and quantity of neural tube defects (NTD) may be governed by their position along the rostrocaudal axis of the embryo. Inductive interactions and genetic regulation during axis development may play a role in the patterning of neural tube defects. A major challenge in the study of human NTD is determining whether the spectrum of developmental neural tube anomalies found in individuals and their families mirror experimental models and are regulated by similar processes.

Methods: We have reviewed the imaging studies and intraoperative findings for over 130 patients who underwent surgery for a NTD from 1994 to 1998; along with reviewing family histories and imaging studies on 450 families. For this study, we catalogued all anomalies according to their type (e.g., anencephaly, myelomeningocele, lipomyelomeningocele, etc.) and their location along the rostrocaudal axis. Secondary disorders were not included such as hydrocephalus or syringohydromyelia.

Results: Greater than 90% of patients who underwent surgery were found to have at least two anomalies of varying pathology. Most common was a clustering of defects beginning at the posterior hindbrain level and caudal or starting at the anterior hindbrain and rostral. Therefore, location appeared to be important in analyzing groupings of defects in individuals and families.

Conclusions: The findings correlate well to the pattern of early genes expression, inductive models of the embryonic axis, and mutant NTD animal models. We suggest that NTD should be studied by their location along the rostrocaudal axis and that specific mutant genes may be identified by the observed pattern of NTD in an individual or a family.

32. Intrauterine Myelomeningocele Repair: Its Effect on the Chiari Malformation

Noel Tulipan, MD, Marta Schulman, MD (*Nashville, TN*),
Joseph P. Bruner, MD (*Nashville, TN*)

A series of patients have undergone intrauterine closure of their myelomeningocele at Vanderbilt University Medical Center. Thus far four such patients have been born. Of those, two have required ventriculoperitoneal shunting, one at three weeks and the other at three months of age. It was noted on postnatal ultrasound that none of the four seemed to have the classic tonsillar herniation associated with the Chiari II malformation. These findings were confirmed with an MRI scan in each case. While each infant had other stigmata of the Chiari malformation such as tectal beaking and a small posterior fossa, none had inferior displacement of the fourth ventricle or other evidence of migration of the posterior fossa contents into the spinal canal. A retrospective analysis of fifty consecutive ultrasound examinations of newborn myelomeningocele patients born at Vanderbilt revealed only two with similar findings. It is suggested that intrauterine repair of a myelomeningocele may eliminate the forces that lead to downward hernation of the cerebellum and brainstem thereby preventing or reversing this component of the Chiari malformation.

33. First Reported Cases of Hemifacial Spasm as the Presenting Finding in Three Patients with Lhermitte-Duclos Syndrome

Charles Kanos, MD, Robert A Sanford, MD (*Memphis, TN*),
Michael Muhlbauer, MD (*Memphis, TN*), Derek Bruce, MD (*Dallas, TX*)

Three cases of Lhermitte-Duclos Syndrome (Dysplastic Gangliocytoma) presenting as involuntary spasm of the face are discussed. Review of the literature demonstrates a typical presentation of this syndrome consisting of signs and symptoms of elevated intracranial pressure due to obstructive hydrocephalus and posterior fossa compression. In our series, two children presented with intermittent spasmodic blinking of the right eye, and one patient involuntarily rotated the right eye upwards with narrowing of the palpebral fissure. Blinking was the only finding in one patient and two had involvement of the entire ipsilateral face and ipsilateral extremity weakness and ataxia. There was no other cranial nerve involvement. Average age at presentation was 13.3 months (range 12-15 months). One child underwent surgical resection of a gangliocytoma without resolution of symptoms. All three patients had typical radiologic findings. To our knowledge, these are the first reported cases of Lhermitte-Duclos syndrome presenting with hemifacial spasm.

This nonprogressive hamartoma (?) may be mistaken for low grade astrocytoma. The characteristic MR appearance and unusual clinical presentation may forewarn the neurosurgeon and avoid unnecessary surgical resection.

34. Functional Reorganization in the Homunculus: Electrocorticographic Evidence

John Honeycutt, MD, Paul Francel, MD, PhD, K.J. Oomen
(Oklahoma City, OK)

Functional reorganization of the cerebral cortex is well known, but there is little evidence in the literature of motor reorganization documented by electrocorticographic mapping. We have operated on five patients for intractable seizures that required electrocorticographic mapping of the homunculus. Using subdural grids, each patient had corticography and video EEG to help plan surgery for lesions located in the precentral gyrus. The motor and sensory cortices were mapped in each case and the relationship of the epileptogenic focus correlated to the homunculus. An excellent example is a 10 year old male with a previous diagnosis of dysembryoplastic neuroepithelial tumor, who underwent monitoring and mapping of the motor cortex. With mapping we were able to show reorganization of his motor strip posterior to his sensory cortex. The tumor was resected and he is now seizure free. This case illustrates true reorganizaion by the developing brain, not a cortical shift secondary to mass effect from the tumor. We have seen similar, but less dramatic, cases in our other patients. The degree of reorganization seems to be more related to the duration of their seizures than the patient's age or etiology of their seizures. By using subdural grids, electrocorticography has played an important role in planning for resection of epileptogenic lesions located in the precentral gyrus. Although our series is small, it is clear that cortical reorganization can occur and that mapping of this can be crucial in planning resection of lesions in eloquent areas.

35. Cognitive Outcome for Pediatric Patients Following Selective Amygdalo-Hippocampectomy

Lynn B. Blackburn, PhD, Shenandoah Robinson, MD (*St. Louis, MO*),
T.S. Park, MD (*St. Louis, MO*), Blaise F. D. Bourgeois, MD (*Boston, MA*)

Rationale: Selective amygdalo-hippocampectomy (AH) was developed to treat intractable partial complex seizures (CPS) while sparing lateral temporal cortex. The current study evaluated the efficacy and cognitive morbidity (CM) of this procedure.

Methods: Outcome for 17 patients (Mean age: 15.49) who had undergone AH and returned for 6 month or one year follow-up were examined. Chi square techniques were used to examine the relationship between seizure outcome and patient characteristics (MRI, PET, seizure laterality, gender, age at onset, years with seizures). CM was evaluated through calculation of pre to post surgery change scores for IQ, rote auditory memory (RM), story memory (SM), design memory (DM), and naming, with significant change defined as a difference $>.5$ standard deviations.

Results: 71% of patients became seizure free. 100% of patients with left temporal onset became seizure free compared to 37% with right temporal onset ($p < .005$). Presence of a normal MRI scan ($p < .025$) or bilateral hypometabolism on PET ($p < .012$) was associated with persistent seizures. Seizure outcome and laterality of surgery was not statistically related to CM. Percent of patients showing CM are as follows: Verbal IQ = 18%; Performance IQ = 18%; Naming = 30%; RL = 33%; SM = 7%; DM = 30%. Skill loss for Verbal IQ and DM occurred only in patients with right resection, while 3 of 4 showing declines in naming had right resections.

Conclusions: Results suggest that AH is an effective method for treatment of intractable CPS. MRI and/or PET findings ipsilateral to seizure focus appear important in patient selection. However, differences in organization of the right and left mesial temporal structures may also have contributed to superior outcome in left temporal patients. AH resulted in no CM for most patients. Comparison of findings to children undergoing standard temporal resection is necessary to determine if sparing of lateral cortex reduces CM.

36. Multi-Stage Epilepsy Surgery in the Pediatric Population: Preliminary Results

Alon Mogilnor, MD, PhD, Werner K. Doyle, MD, Steven V. Pacia, MD, Orrin Devinsky, MD, Jeffrey H. Wisoff, MD, Howard L. Weiner, MD
(*New York, NY*)

Introduction: Patients with extratemporal epilepsy have poorer clinical outcomes following resective surgery than those with temporal lobe epilepsy. In some patients, resection of an unidentified epileptic focus may unmask a previously unidentified focus that contributes to persistent seizures. To improve outcome of extratemporal epilepsy surgery in children, we utilized a novel strategy employing staged resections.

Methods: Eight medically refractory seizure patients (average age 10 years, range 6 months-18 years) underwent staged surgery. All patients underwent subdural electrode placement for monitoring. Subsequently, the patients underwent resection of epileptic foci and/or multiple subpial transections (MSTs), followed by replacement of the electrodes. After a second monitoring period, further resection was performed if appropriate. Post-operative outcome was graded on a scale: 1=seizure free, 2=seizures reduced in frequency/intensity, 3=no improvement.

Results: The mean duration of monitoring was 11 days, with an average of six days from first to second procedure, and four days from second to third procedure. In six patients, additional resections and/or MSTs were performed for persistent seizures. In three patients, initial resection unmasked epileptic foci not identifiable prior to initial surgery, which were resected at the third stage. Two of these three children are now seizure free. Average follow-up was 14 months, with 50% of patients seizure free (Grade 1), 38% improved (Grade 2), and one patient unimproved. No infections or other complications occurred.

Conclusions: In patients with extratemporal epilepsy, multi-stage resection may improve seizure outcome, without additional risk. While this approach appears promising, more patients and longer follow-up will define risks, benefits, and characterize the optimal candidates.

37. Recent Surgical Management of Epilepsy in Children with Cortical Dysplasia

Mark Lee, MD, PhD, Karl Sillay, Joseph R. Smith, MD, FACS
(*Augusta, GA*)

Epilepsy surgery is increasingly being accepted as a treatment for intractable epilepsy in children. While it is generally accepted that surgical results for intractable epilepsy associated with structural lesions is generally good, there is a relatively paucity of data on the surgical treatment of epilepsy in children with cortical dysplasia. Thus we find it timely to review our recent surgical results and experience in children with epilepsy and cortical dysplasia. Seven children with cortical dysplasia (age at surgery, 7-18 years, mean 12 years) underwent ablative resections at our institution over the past 5 years (1993-97). All children had medically intractable epilepsy (duration of seizure disorder, 7-14 years, mean 9 years), and had failed multiple medical regimens. All children underwent magnetic resonance (MR) imaging. Pre-operative evaluations included 24-hour video EEG monitoring and Wada tests in age-appropriate patients. Five children underwent further evaluation utilizing invasive monitoring. Surgical resection was tailored according to the results of invasive monitoring, intraoperative cortical EEG, and intraoperative functional mapping. Seizure outcome was reviewed after 1-year follow up.

Four children underwent extratemporal resections, one child underwent a temporal resection, and two children underwent functional hemispherectomies. All children were seizure free one year after surgery. In addition to the analysis of outcome, we will discuss in detail the clinical presentation, the MR imaging, the preoperative evaluation, the surgical technique, and the lesional pathology of children with epilepsy secondary to cortical dysplasia. In doing so, we hope to further elucidate this group of patients, and provide additional data for this type of epilepsy surgery for children.

38. Pallidotomy as a Treatment Option for Pediatric Movement Disorders

Charles Teo, MD

Juvenile, focal dystonia, post-traumatic tremor disorder (PTTD) and choreoathetoid cerebral palsy (CACP) after a moderately severe closed head injury, are uncommon conditions. Medical treatment has been largely unsuccessful. Stereotactic thalamotomy has been the most frequently used treatment for medically refractory PTTD and dystonia, with reasonable success. However, a particularly high rate of complications has been reported with thalamotomies in the treatment of these conditions (up to 30%). Limited data seem to suggest that ventral posterior pallidotomy offers a valid option without the significant complications associated with thalamotomy. Patients referred to the Arkansas Children's Hospital for surgical treatment of PTTD (6), dystonia (2) and CACP (4) were reviewed for details regarding their neurological presentation, clinical and radiographic findings, and post-operative follow-up. All patients underwent stereotactic pallidotomy with radiofrequency lesioning following a macro-electrode stimulation mapping of the globus pallidus. Preliminary localization of the lesion target was determined with magnetic resonance imaging and ventriculographic findings. Twelve patients (7 males, 5 females) were treated from 1994 to 1998. The ages at the time of surgery ranged from 11 to 18 years. The duration of coma in those with PTTD ranged from 5 to 12 weeks. PTTD developed after an interval of 4 to 16 months. After a mean follow-up of 18 months, all patients demonstrated greater than 75% reduction in their movement disorder and improvement in their level of function. A video tape of PTTD and CACP before and after the surgery will be shown as evidence of improvement. Although damage to several basal ganglia, midbrain, and cerebellar nuclei and their pathways have been implicated, the mechanism of PTTD and associated movement disorders remain unknown as does the pathophysiology of juvenile dystonia and CACP. As in Parkinson's Disease, interruption of pallidothalamo-cortical circuit via the ventral posterior pallidotomy results in reduction of tremor and dystonia. Pallidotomy may offer an alternative surgical option for pediatric movement disorders.

39. Clinical Presentation of Optic Pathway Tumors in Young Children with NF1

Kimberly Bingaman, MD, Joseph Petronio, MD, Arlene Drach, MD
(Atlanta, GA)

Introduction: Optic pathway tumors (OPTs) are commonly associated with NF1 in younger children; their natural history and optimum management have been the subject of much discussion and clinical research. As a result of the NF1 Optic Pathway Glioma Task Force (1995) and the National Institutes of Health (NIH) Consensus Development Conference on Neurofibromatosis (1987), routine screening neuroimaging studies on asymptomatic children with NF1 have been discouraged, based on the assumptions that: (a) progressive OPTs in children can be detected on serial routine ophthalmologic examinations; and (b) progressive OPTs are sufficiently slow-growing that early detection rarely alters their clinical course.

Methods: A single-institutional, retrospective review of 8 children with NF1 diagnosed with OPTs from November, 1991 through January, 1998.

Results: There were 4 females and 4 males studied, with a median age of 5.4 (range, 8 months to 6.25) years at the time of diagnosis. Five patients developed progressive visual loss which required treatment; three had been routinely followed by outside ophthalmologists or optometrists. More disturbingly, three patients presented with profound visual loss as the initial symptom of their OPT. Visual function improved and/or stabilized with treatment in five of the six treated patients.

Discussion/Conclusions: This review questions the practicality, efficacy, and safety of routine screening ophthalmologic examinations, used alone, for the diagnosis of OPTs in pre-verbal children with NF1. We believe that this limited series demonstrates that these lesions have the potential for progressive growth and visual deterioration, and frequently respond to currently available cytotoxic agents or external beam irradiation.

40. Interhemispheric Transcallosal Resection of Mass Lesions in Childhood: Review of 12 Years Experience*

Mark A. Mittler, MD, Michael L. Levy, MD, J. Gordon McComb, MD

A variety of complications can occur via a transcallosal corridor. The last 12 years of experience by two surgeons at one institution were reviewed with regard to morbidity. A retrospective review of only those cases performed in an open transcallosal fashion for mass lesions were included. Patients were excluded if adequate follow-up was not achieved.

53 patients were included in this series. The average age was 7.8 years (range .08 to 17.67 years). 55% (29/53) were male. During the operative procedures 41.5% (22/53) of cases required coagulation and lysis of bridging cortical veins from the convexity to the sagittal sinus. Average operative blood loss was just over 200ml (range 20 -1400 ml). Average length of intensive care unit stay was 3 days (range 1-12 days). 13% (7/53) of patients required intubation beyond the surgical procedure. 15% (8/53) of patients experienced post-operative seizures which required antiepileptic pharmacotherapy. 9% (5/53) of patients had evidence of post operative memory disturbances. 30% (16/53) of patients had transient post-operative hemiparesis. 22% (12/53) had post-operative disorders of sodium regulation. 32% (17/53) required permanent cerebrospinal fluid (CSF) diversion.

Transcallosal approaches to mass lesions in children are generally well tolerated. In our experience, approximately one-third of these patients require subsequent operative intervention for CSF diversion, however, less than 10% have evidence of significant memory impairment. Although 30% of patients had post-operative weakness, the vast majority of these were transient. This occurrence was higher in those patients who required bridging vein coagulation (40%) than those who did not (22.6%). Outcome did not appear to be otherwise affected by vein coagulation.

41. A Contemporary Algorithm for the Management of Posterior Third Ventricular Tumors

Sivakumar Jaikumar, MD, Mark Davies, MD (*Sydney, NSW, Australia*),
Charles Teo, MD (*Little Rock, AR*)

Approaches to tumor of the posterior third ventricle are challenging. Problems faced commonly include occipital lobe damage with the supratentorial approach, disconnection syndromes with the transcallosal approach, seizures and thalamic syndromes with the transventricular approach, and difficult access with the infratentorial approach. Furthermore, conventional management of secondary hydrocephalus can result in infection and microscopic spread of malignant tumors. We present a series of 17 patients with posterior third ventricular tumors both benign and malignant. As all patients in this series had secondary hydrocephalus, they were managed initially with endoscopic cerebrospinal fluid sampling, tumor biopsy and a third ventriculostomy. In four patients, no further surgical treatment was necessary. The remaining patients underwent an interhemispheric retrosplenium approach to the posterior third ventricle for definitive treatment of their tumors. Complete or near complete removal was achieved in all cases with a 100% incidence of transient difficulty with conjugate eye movement. However, there were no permanent complications related to either the endoscopic or the microsurgical procedures and no patient required extracranial cerebrospinal fluid diversion. All patients have been followed for a minimum of six months. We believe this treatment algorithm can be applied successfully in the management of all posterior third ventricular tumors with secondary hydrocephalus.

42. Radical Therapy of Choroid Plexus Carcinoma

George Malcolm, MD, Edward Chow, MD, Robert A Sanford, MD,
Larry Kun, MD (*Memphis, TN*)

Introduction: Choroid plexus carcinoma (CPC) is a highly invasive tumor with dismal prognosis. We present our experience of CPC treated by radical resection, chemotherapy (CT), and radiosurgery.

Method: Ten children were treated for CPC (1985-1997). Following surgery craniospinal imaging and CSF cytology was performed. Adjuvant treatment with CT and/or craniospinal irradiation (CSI) with focal boost to the primary site. CT employed cyclophosphamide, etoposide, vincristine, and platinum compound. Median CSI dose was 35.2 Gy and median primary site dose was 55.2 Gy.

Results: Median age at diagnosis 12 months (1.5-27) with location in lateral ventricle (9) and thalamus (1). Seven underwent gross total resection (GTR), two incomplete resection (IR) followed by interval by GRR and one biopsy and IR. Nine of the patient had CT and 5 CSI. Mean follow up was 50 months (3-153). 6 patients remained without evidence of disease, 2 alive with disease and 2 dead. Two have significant disability.

Discussion: This study supports the contention that GRR improves prognosis. Adjuvant CT and CSI have been more controversial in the literature. Our results suggest a role for adjuvant CT, supporting the view that CT decreases tumor vascularity thus facilitating subsequent surgical resections. The place of radiation is less certain, perhaps being useful in children with progressive disease on chemotherapy.

Conclusion: Prognosis for CPC is good with GTR and there appears to be a role for CT. Radiation may be of use for salvage.

43. Pineal Location PNETs in Children*

Michael Wang, Steve W. Chang, MD, Mark A. Mittler, MD, Michael L. Levy, MD, J. Gordon McComb, MD

Pineal location primitive neuroectodermal tumors (PNET or pineoblastomas), represented 18/42 (43%) of patients seen with pineal location tumors at our institution over a fifteen year period. These tumors were compared to those present in the posterior fossa to see if there were any differences. The male/female ratio was 10 to 8 and the mean age of presentation was 64 mo (± 64 mo). Of the group, 15/18 (83%) had symptoms of raised intracranial pressure secondary to progressive hydrocephalus.

Operative approach was supra-tentorial, interhemispheric in 14/18 (78%). Infratentorial-supracerebellar in 3/18 (17%) and a stereotactic biopsy 1/18 (5%). Total resection as measured by post-operative MRI was obtained in 9/18 (50%). Surgical complications included transient hemiparesis 2/18 (11%), persistent hemiparesis 1/18 (5%), transient dysconjugate gaze 1/18 (5%), persistent dysconjugate gaze 1/18 (5%), air embolism 1/18 (5%), transient post-operative seizures 4/18 (22%), CSF diverting shunts were required in 14/18 (78%).

Histologically, 16/18 were pure PNETs with one having elements of anaplastic astrocytoma and the other of an atypical rhabdoid tumor. One patient had diffuse subarachnoid spread of tumor at initial presentation. Patients receiving adjuvant therapy included 8 getting chemotherapy alone, 1 getting radiation therapy alone and 6 getting chemotherapy plus radiation. Two patients received no adjuvant therapy.

Mean follow-up was 89 months (± 68 mo). Longevity was 46 months (± 15 mo) for the series, 14 months (± 14 mo) for those who died, and 67 months (± 54 mo) for survivors. No one parameter of significance was found between survivors and non-survivors, as to presentation, histology, or treatment modality except a trend toward better outcome with gross total removal.

44. High-grade Astrocytomas in Children

Li Anmin, MD, Zhang Xiang, MD (*Peoples Republic of China*)

High-grade astrocytomas comprise about 10% of intracranial tumors in children. A better prognosis in children than in adults has been reported for patients with these neoplasms, although the reasons for this survival advantage are uncertain. To determine whether any consistent factors were associated with long-term survival, we reviewed the records of 73 children with high-grade non brain stem gliomas who were treated at our hospital between 1980 and 1997. Histology was reviewed and classified according to the World Health Organization scheme, and neuroimaging studies were examined to determine the extent of resection, in both instances by individuals who were unaware of the patients' outcomes. The median overall survival for the 68 patients who survived the perioperative period was 21.5 months; 21 are currently alive, with median follow-up of 71.5 months. The median progression-free survival (PFS) was 17.5 months; 11 patients remain progression-free with a median follow-up of 92 months. The extent of resection at initial operation was associated most closely with PFS and overall survival as revealed by multivariate analysis. The 29 patients who underwent subtotal (<90%) resection and the 31 who underwent near-total (90-99%) resection had median PFS of 11 and 23 months, respectively ($p=0.23$), and overall survival of 21 and 32, 5 months, respectively ($p=0.02$). None of 15 patients who underwent gross total removal of tumors as confirmed by postoperative imaging had disease progression, with a median follow-up of 97 months ($P=0.0001$). All of the tumors that underwent gross total resection were situated within the cerebral hemispheres. Both tumors location and seizures were significantly associated with outcome as determined by univariate analysis, but because of the overwhelming impact of resection extent on outcome, these factors were not independently associated with outcome as revealed by multivariate analysis. Histology was associated with outcome in the subgroup of patients with incompletely resection hemispheric tumors, in which children with anaplastic astrocytoma had a significantly better PFS than those with glioblastoma multiforme ($P=0.006$). In summary, our results support the role of cytoreductive surgery in the treatment of cerebral hemispheric high-grade astrocytomas in children, which may encompass a biologically distinct group of tumors that, by virtue of their location and growth characteristics, are amenable to aggressive resection. The prognosis for children with deep-seated lesions and for those with subtotally resected hemispheric lesions is generally poor with conventional therapy.

45. The Role of High-Dose Chemotherapy (HDC) and Autologous Stem Cell Rescue (ASCR) in the Treatment of Malignant Gliomas of Childhood

Howard L. Weiner, MD, Mark V. Sapp, MD, Sharon Gardner, MD,
Jeffrey H. Wisoff, MD, Jonathan L. Finlay, MB, ChB (*New York, NY*)

For most children with newly diagnosed malignant gliomas, the outcome remains poor, despite surgery, irradiation, and conventional chemotherapy. To improve the outlook for such patients, novel strategies utilizing HDC with ASCR have been developed. These strategies, initially conducted in patients with recurrent tumors, were then extended to children with newly-diagnosed malignant gliomas. 36 patients (25 GBM, 11 AA), median age 12.6 years, received HDC/ASCR after initial recurrence. Overall objective response rate was 21%, and overall toxic mortality was 19%. Nine patients (25%) survived event-free at a median follow-up of 48 months. Event-free and overall survivals (EFS, OS) at 4 years from progression were 22% and 21%, compared to 2% and 5% in a group of 57 similar patients receiving conventional chemotherapy. The only significant favorable prognostic variable was minimal residual tumor (<3cm) with HDC/ASCR. Eleven patients with newly diagnosed GBM, median age 12 years, received myeloablative thiotepa, etoposide, and carmustine with ASCR, followed by focal radiation therapy (RT). Five (45%) developed significant, non-fatal pulmonary and/or neurologic complications. Two-year EFS and OS were 42%. More recently, we have treated eight patients with newly-diagnosed GBM, median age 21 (range 6-50), by replacing carmustine with carboplatin, discarding etoposide, and giving RT prior to HDC/ASCR. 50% (4/8) patients are progression-free at 34.8, 12.8, 10.4, and 7.5 months post-ASCR, with no toxic deaths and no permanent toxicities. In conclusion, these preliminary data are highly encouraging, supporting the role of these novel chemotherapeutic strategies in children and young adults with malignant glioma.

46. A Multi-Institutional Retrospective Study of Intracranial Ependymoma in Children: Identification of Risk Factors

Matthew Smyth, MD, Biljana Horn, MD, Mitchel S. Berger, MD (*San Francisco, CA*), Richard Heideman, MD (*Memphis, TN*), Russel J. Geyer, MD (*Seattle, WA*), Ian Pollack, MD (*Pittsburg, PA*), Roger Packer, MD (*Washington, DC*), Joel Goldwein, MD (*Philadelphia, PA*), Tandori Tomita, MD (*Chicago, IL*), Paula Schomberg, MD (*Rochester, MN*), Joan Ater, MD (*Houston, TX*), Lori Luchtman-Jones, MD (*St. Louis, MO*), Kenneth Rivlin, MD, PhD (*New York, NY*), Kathleen Lamborn (*San Francisco, CA*), Michael Prados, MD (*San Francisco, CA*), Andrew Bollen, MD (*San Francisco, CA*), Mitchel Berger, MD (*San Francisco, CA*), Gary Dahl, MD, Steve Huhn, MD (*Palo Alto, CA*), Elizabeth McNeil (*Washington, DC*), Kathleen Patterson, Dennis Shaw, Michael Kubalik, Carolyn Russo, MD (*San Francisco, CA*)

Introduction: The goal of this multi-institutional retrospective study of children with intracranial ependymoma was to identify risk factors associated with unfavorable overall survival (OS) and progression-free survival (PFS).

Methods: Clinical data including demographics, tumor location, spread, histology and details of surgery, radiation treatment and chemotherapy were collected. Clinical characteristics and univariate and multivariate analyses of risk factors for OS and PFS are presented.

Results: 11 United States institutions contributed 83 patients treated from 1987 to 1991. OS at 5 and 7 years was 57% and 46%, and PFS at 5 and 7 years was 42% and 33%. Patients ≤ 3 years of age differed from the older group by more common infratentorial location, less common gross total resection (GTR) and post-operative use of chemotherapy rather than radiation. This younger group of patients had worse survival ($p < 0.01$) than the older group. Other than young age, less than gross total resection and WHO-II grade 3 histology were significant adverse risk factors for PFS in both univariate and multivariate analysis ($p < 0.05$). Progression at the original tumor location, present in 89% of patients, was the major pattern of tumor recurrence. Patients with GTR had significantly improved outcomes as compared to patients with less than gross total resection. Tumor location (infratentorial lateral or invasive) also correlated significantly with poor outcome, but when controlled for extent of resection there was no significant difference.

Conclusions: Adverse outcome in childhood intracranial ependymoma is related to age (≤ 3 years of age), histology (grade 3), and degree of surgical resection (less than gross total resection). Tumor location is a significant predictor of outcome, and is likely closely linked to extent of resection.

47. Delayed Repair of Open Depressed Skull Fracture*

Daniel Curry, MD, David M. Frim, MD, PhD (*Chicago, IL*)

Introduction: Elevation and repair of open, depressed skull fracture is often thought of as an emergency procedure. Common indications for emergent elevation of a depressed skull fracture have been dural tear, seizure, gross contamination, or mass effect from bone or a sizable underlying intracerebral hematoma. As treatment of head injury moves towards management of cerebral perfusion pressure (CPP) rather than intracranial pressure (ICP), we sought a way to maximize CPP in the initial treatment of head injured patients with depressed skull fractures that would eventually require surgery by delaying surgery, where possible, until after the initial period of high ICP.

Methods: Over a 12 month period, 7 patients (all male, ages 1-15) were admitted to our institution with the diagnosis of open, or open depressed skull fracture without significant mass effect requiring urgent decompression. All had significant head trauma with altered mental status and GCS 3-12. Patients were treated with antibiotic prophylaxis (nafcillin, ceftriaxone, metronidazole), seizure prophylaxis (phenytoin), and underwent CPP management in an ICU setting as indicated by intracranial pressure monitoring. Length of medical management of CPP ranged from 4 to 12 days. Upon stabilization of CPP, patients were operated for repair of their dural, bone and scalp injuries.

Results: All seven patients treated in the above manner suffered no ill effects from their delayed surgery: there was no meningitis, no late seizures, and no CSF leak. Complications attributable to delay were not present at follow up ranging from 6 to 18 months.

Conclusions: We have delayed surgery for repair of open depressed skull fractures in order to maximize medical management of CPP in the setting of acute trauma. Among other considerations, the risk of intraoperative hypotension occurring at a time of acutely raised intracranial pressure was avoided by this delay. We conclude that there is a role, in this specifically defined subset of head trauma patients, for delayed surgical repair of open depressed skull fractures.

**Considered for Shulman Award*

48. Post-Traumatic Seizures in Children: Is Routine Admission Necessary?

Mark Dias, MD, Frank Carnevale, MD (*Buffalo, NY*), Veetai Li, MD (*Buffalo, NY*)

Objective: A survey of pediatric neurosurgeons showed that 86% routinely admitted children with post-traumatic seizures (PTS) for a brief period of observation. We wished to determine whether certain children meeting pre-defined criteria could instead be safely discharged from the Emergency Room.

Methods: We reviewed the records of children admitted during the past 5 years with a diagnosis of seizure and head injury. Children with a minor head injury, a post-traumatic seizure occurring within 24 hours of injury, and no intracranial abnormalities on admission CT scan were included. Children with previous neurological conditions, a history of prior seizures (other than post-traumatic or febrile seizures), a prior history of anticonvulsant use, or intracranial abnormalities on the admission CT scan were excluded. The charts were abstracted for child's age, gender, length of admission, previous history of PTS or febrile seizures, mechanism of injury, location of impact, time between impact and PTS, the number, length, and type of PTS, Glasgow Coma Score on admission, subsequent complications, and hospital costs.

Results: Seventy-one children met inclusion criteria. Ten children presented with status epilepticus and required anticonvulsants and ICU admission. Among the 61 remaining children with simple PTS, none had further seizures during the follow-up period, and none had significant complications. The average cost of hospitalization was known for 58 of the 71 children and amounted to \$1898 per patient; extrapolating to the entire group yields an estimated total hospital cost of \$134,758 for the 71 patients.

Conclusions: Our data suggest that children with isolated minor head injuries and simple PTS who recover fully in the emergency room, whose CT scan shows no intracranial abnormalities, and who have no prior history of neurological disease, epilepsy, or anticonvulsant use may not be at increased risk for recurrent seizures or neurological complications, and could potentially be sent home to a reliable caretaker and a stable home situation.

49. Neurological Deterioration after Closed Head Injury in Childhood: Incidence and Outcome*

Jill W. Donaldson, MD, Hugh J. L. Garton, MD, William E. Snyder, Jr. MD, Thomas G. Luerssen, MD (*Indianapolis, IN*)

Methods: A prospectively collected database of 850 consecutive head injured children admitted to Riley Children's Hospital (Indianapolis, IN) was surveyed to identify mild or moderately head injured children who deteriorated neurologically within 24 hours of admission.

Results: Over a period of nine years, early deterioration occurred in 34 of 663 (5.1%) children with admission GCS of 9-15, including 19 of 598 children with GCS 13-15 (Group I) and 15 of 65 children with GCS 9-12 (Group II). The mean ages were 6 years (Group I) and 4 years (Group II). The major presenting symptoms in both groups were loss of normal consciousness or seizures. In Group I the most common CT abnormalities were skull fracture (68%), intracerebral hemorrhage (26%), epidural hematoma (21%), cisternal compression (21%), and subdural hematoma (21%). In Group II common CT findings were skull fracture (67%), cisternal compression (40%), and subarachnoid hemorrhage (27%). Overall, children with radiographic abnormalities were 3.7 (95%CI:1.33<RR<10.44) times more likely to deteriorate than those without them. None of the children died, and good neurologic outcome (GOS>3) at discharge occurred in 89% (Group I) and 47% (Group II). Long term outcomes were even better.

Conclusions: The risk of neurological deterioration after head injury in childhood is related to the severity of injury and the findings on the admitting CT scan. The processes that lead to deterioration can be interrupted, and, if treated aggressively, most children with this syndrome can have good neurological outcomes.

50. Intracranial Pressures During Normal Care, Accidental Injury, Intentional Abuse and CPR in a Model Infant

Eric Adelman, Kristin Marit Mawk (*Des Moines, IA*), John R. Mawk, MD (*Des Moines, IA*)

A realistic model of a 6 week old baby was developed for the study of ICP during simulated normal care, accidental injury, abuse and CPR. The model permits the setting of baseline ICP to various levels and also reflects changes in ICP produced by thorax compression. As expected, gentle care has little effect on ICP, irrespective of the baseline pressure. Accidental injuries, including falls up to 1 meter, produce sharp, sometimes large increases in ICP, proportional to the simulated accident. CPR causes only slow, sinusoidal variations in pressure.

Striking the model in various manners produces large ICP changes with often complex waveforms. Most importantly, shaking the model produces three related pressure fluctuations: first, we noted a slow, steady ICP rise caused by torso compression, followed by positive-negative-positive ICP waves as the infant is shaken, followed by a long negative and a long positive wave when the infant is thrown down. The dP/dT during shaking is on the order of ± 1000 to 1500 torr per second. We believe that these severe pressure changes may be responsible for the injuries seen in the pure-shaking form of child abuse; alternatively stated, this data suggests that shaking alone may injure infants.

51. Spinal Cord Injuries in Fatal Inflicted Trauma in Infants

Ann-Christine Duhaim, MD, Cindy Christian, MD (*Philadelphia, PA*),
Lucy B. Rorke, MD (*Philadelphia, PA*)

Introduction: The pathophysiology responsible for death in fatal inflicted injuries remains incompletely understood. This study was undertaken to identify the incidence and clinical correlates of spinal cord injury in this population.

Methods: The autopsies and medical records of 35 consecutive infants thought to have died of inflicted injuries who underwent complete brain and spinal cord examination were reviewed. Records were reviewed for demographics, history, presenting symptoms, initial and best physical examination findings, history of apnea, seizures, associated injuries, and radiologic findings.

Results: All patients, with exceptions to be discussed, had subdural and/or subarachnoid hemorrhage. Injury to meninges or nerve roots was seen in 27/35 children, and spinal cord parenchymal pathology, usually at the cervicomedullary junction or upper cervical region, was seen in 24 children. There was no correlation between spinal cord pathology and age, presenting symptoms, reported mechanism, apnea, movement of the child, or unilateral or bilateral "big black brain." Spinal cord injury was not seen in isolation from brain injury.

Conclusions: Spinal cord pathology is found commonly in fatal inflicted injury, but in the present series was not found independent of brain injury, and was not correlated with clinical indices of spinal cord injury such as apnea or decreased movement. The implications for these findings in the pathophysiology and mechanisms of inflicted injuries will be discussed.

52. Non-Accidental CNS Injury in Children and Judicial Outcome

Stephen Huhn, MD, Catherine Albin MD (*San Jose, CA*),
Michele M. McCoy, JD (*San Jose, CA*)

The diagnosis of non-accidental head injury in children initiates a complex process involving medical, social, law enforcement, and legal organizations. The duty of the physician as a “mandated reporter” is fulfilled once the appropriate social service is notified. In contrast, the burden of determining the identity of the perpetrator and subsequent prosecution lies with the social service team, child protection agency, law enforcement, and ultimately the court. The purpose of this study was to examine the factors influencing the judicial outcome in a series of “shaken baby syndrome” cases occurring in a single jurisdiction. The medical records of 34 children diagnosed with non-accidental CNS injury over nine years at a tertiary center were retrospectively reviewed. At least 60% of cases were not referred to the district attorney’s office responsible for child abuse prosecution. Of 14 patients referred to the court, there were four fatal and ten non-fatal cases. Of the 10 non-fatal cases, three trials are still pending, two cases were dismissed because of insufficient evidence, and the remaining five cases resulted in penalties ranging from time served to 5 years, with most sentences under one year. The legal outcome for fatal cases also covered a broad spectrum. Analysis of the investigative mechanism of inflicted injury suggests a process that is inconsistent and characterized by a low percentage of prosecution. The conviction rate and penalty for child abuse is similarly variable. The factors involved in the judicial outcome of non-accidental CNS injury in children will be reviewed and the need for joint medico-legal research emphasized.

53. Ventricular Anatomy and Shunt Catheters

Bruce A. Kaufman, MD, T.S. Park, MD (*St. Louis, MO*)

Introduction: What length of a ventricular catheter can remain within a normal ventricle and clear of the choroid plexus? The length of catheter that might remain clear of choroid plexus in normal ventricles was defined, and compared with the inlet positions on current ventricular catheters.

Methods: In 30 normal children (age 1 m - 20 yr, median 7.7 yr) MRI was used to measure the dimensions of the anterior horn in planes typically used for catheter placement. For anterior placements, the intraventricular length (ventricle entry to Foramen of Monro) was measured for a standardized catheter route ("As") and for a route yielding a maximum length ("Amax"). For posterior placements, the length (ventricle tip to Foramen of Monro) was obtained for a standardized catheter placement to the ipsilateral ("Pi") and contralateral ventricle ("Pc"), as well as measuring a maximum length in a curved trajectory ("Pmax").

Results: The average length in cm. (and range) for the various trajectories was: As=1.5 (1.1-1.9), Amax=1.7 (1.2-2.2), Pi=1.6 (1.2-2.1), Pc=2.0 (1.4-2.9), Pmax=2.8/3.1 (2.1-3.6). A non-standard shunt insertion site did not affect the length of catheter within the ventricle. Current ventricular catheters have proximal inlets 1.6 to 2.4 cm from the catheter tip.

Conclusions: Given these anatomical dimensions, current ventricular catheters cannot remain within the ventricle and consistently be placed away from the choroid plexus regardless of approach. This may contribute to the similar proximal occlusion rates for the differing placements. Proximal catheters inlets may need to be redesigned to cover a shorter distance.

54. Ventricular Catheter Tip Location: Predictive Probability of the Surgeons Aim and Effect on Shunt Failure—Results from the Pediatric Shunt Design Trial**

Sagun Tuli, MD, B O'Hayon, Michelle Clark, JM Drake (*Toronto, Ontario*),
J.R.W. Kestle (*Vancouver, British Columbia*)

Introduction: The ideal location of the ventricular catheter tip in CSF shunts has generated controversy since Becker and Nulsen (1968) first addressed this issue. Previous studies have lacked currently acceptable methodological and statistical analysis to answer this question. We analyzed data from the pediatric shunt design trial in terms of the surgeon's intended and actual ventricular catheter tip location.

Method: The surgeon's intended ventricular catheter tip location during shunt insertion was prospectively recorded in 344 patients. Actual ventricular catheter location was classified as occipital, frontal, atrial, third ventricular, imbedded in brain, or unknown from analysis of the postoperative images of patients with functioning shunts. The predictive probability of the surgeon's intended target was calculated from Cohen's kappa statistic. The contribution of ventricular catheter location to subsequent shunt failure was analyzed by a Cox model with incorporation of time dependent covariates after adjusting for confounding variables. Confounders adjusted for included age, etiology of hydrocephalus, shunt design, ventricular size (measured at up to six different time periods, using a modified Evan's ratio), ventricular catheter tip environment (defined as tip surrounded by brain, touching brain or surrounded by CSF, obtained at up to five time periods).

Results: The probability of the catheter tip being in the intended frontal location was 0.52 (CI=0.45-0.60) and the occipital location 0.68 (CI=0.56-0.78). The overall reliability of the surgeons intended target was only fair to moderate with a Cohen's kappa statistic of 0.465, CI=0.375-0.558. In terms of shunt failure, frontal and occipital ventricular catheter tip location had reduced Hazard Ratios (HR=0.60, CI=0.39-0.91, p=0.02 and HR=0.45, CI=0.28-0.74, p=0.001 respectively).

Conclusion: Ventricular catheter tip location is an important contributor for CSF shunt malfunction. Surgeons are currently only moderately able to place catheters in the intended position. Assistive techniques (endoscopy, ultrasound etc) may improve intended catheter placement and lead to reduced shunt failure.

55. A Cost Effectiveness Evaluation of Endoscopic 3rd Ventriculostomy

Hugh Garton, MD[†], John R.W. Kestle, MD, Douglas Cochrane, MD
(*Vancouver, BC*), Paul Steinbok (*Vancouver, BC*)

Introduction: Endoscopic third ventriculostomy (ETV) is an alternative to shunt placement in treating pediatric hydrocephalus. Cost effectiveness analysis can help determine the optimal strategy for integrating these different approaches.

Methods: All patients (N=28) undergoing ETV at BC's Children's Hospital between 1989 and 1998 were matched for age, etiology and number of prior shunt procedures, with patients treated with CSF shunts. Hydrocephalus related resource consumption and outcome (the number of hydrocephalus treatment-free days during follow-up) were retrospectively identified and discounted annually at 5% using standard economic analysis methods outlined by Drummond and colleagues.

Results: Common causes of hydrocephalus were tumor (45%), aqueductal stenosis (34%) and myelomeningocele (9%). At equivalent follow up (median 22 months) the failure rate of the index procedure (need for reoperation) was 46% in both groups. One hydrocephalus related death and one hemiparesis occurred in the endoscopy group compared with no permanent morbidity/mortality in the shunt group. The cost/effect ratios for the two groups were similar. The additional incremental resource use by the shunt group was 4 readmissions (0.14 per pt), 0 reoperations and 3 brain imaging studies (0.09/pt). The additional incremental benefit to the endoscopy group was 34 treatment free days (1.23 days/pt (95% CI: -7.62 to 10.37)). None of these differences were statistically significant.

Conclusion: With a 54% success rate (at 22 months), ETV was slightly less costly and more effective, but these differences were not statistically significant, and do consider the additional morbidity and mortality of ETV. This suggests that more patients, longer follow up or higher success rates are needed to demonstrate cost effectiveness of this therapy.

[†]Disclosure Information

56. Neonatal Ventriculosubgaleal Shunts**

Benjamin Fulmer, MD, Paul Grabb, MD (*Birmingham, AL*), Jerry Oakes, MD (*Birmingham, AL*), Timothy Mapstone, MD (*Birmingham, AL*)

Objective: We report on 32 neonates treated with ventriculosubgaleal (VSG) shunts to determine VSG shunt survival and complications.

Methods: Between 1993 and 1997, 37 VSG shunts were placed in 32 neonates when either the cerebrospinal (CSF) or abdomen was considered unsuitable for ventriculoperitoneal (VP) shunt placement. A ventricular catheter without a valve drained into a surgically created subgaleal pocket.

Results: The etiologies of hydrocephalus were as follows: intraventricular hemorrhage (IVH), n=20; meningitis/ventriculitis, n=6; IVH and infection, n=2; and other, n=4. The mean post-conception age at VGS shunt insertion was 37.2 weeks (33.1 in the IVH group), and the mean weight was 2227 grams (1724 in the IVH group). Average preoperative head circumference was 33.6 cm. The average survival of these 37 VSG shunts (5 children had 2 different VSG shunts) was 35.1 days. Complications were as follows: 1 CSF leakage when sutures were removed; 1 catheter fell into the ventricle upon attempted removal; and 1 child died immediately following VSG shunt revision. There were no infections. All surviving children followed for a minimum of four months after insertion of a VSG shunt have required a VP shunt. Mean follow-up from the time of first VSG shunt insertion was 21.6 months. Four children have died of unrelated causes.

Conclusion: VSG shunts offer a simple, effective, and relatively safe means to temporize hydrocephalus while avoiding the need for external drainage or frequent CSF aspiration in these medically unstable infants until VP shunting is possible.

57. Ventriculo-Subgaleal Shunts for Hydrocephalus in Small Premature Infants

Michael Handler, MD, FACS, FAAP; Patti Batchelder, RN, MSN
(*Denver, CO*)

Maintenance of a well-functioning ventriculoperitoneal shunt is difficult in small premature infants with hydrocephalus. Despite several recent studies reporting very satisfying results, the subgaleal shunt has remained a little-used and little-discussed technique. We have placed subgaleal shunts in 25 small premature infants, modifying a standard ventricular access reservoir by adding a short length of distal tubing with several minimal-resistance, anti-reflux slits to create the shunt. In all infants there was a rapid, dramatic and sustained decompression of ventricular CSF into the subgaleal space. 20 infants had germinal matrix hemorrhage and post-hemorrhagic hydrocephalus, three had in utero events, and two had hydrocephalus associated with spinal dysraphism. Three required replacement of a subgaleal shunt due to early malfunction. 18 infants ultimately required placement of a V-P shunt, and 4 did not; three died. There were no infections. The average weight at subgaleal shunting was 1374 grams, and average age was 28 days. The average longevity of the subgaleal shunts was 61.3 days, and weight at conversion 3104 grams in children who went on to a V-P shunt. We use the system to temporize until the infant has grown to at least 2 kilograms, when a definitive shunt is more likely to function. We conclude that ventriculo-subgaleal shunts are very simple and safe to place and maintain, and provide significant advantages over medications, reservoirs and/or serial tapping, or external ventricular drainage, in the management of hydrocephalus in small premature infants.

58. In Vivo Ventricular Pressure Dynamics When Shunting CSF to Unusual Absorptive Surfaces: A Telemetric Study

David Frim, MD, PhD, Ilyas Munshi, MD (*Chicago, IL*),
Lilliana Goumnerova, MD (Boston, MA), Joseph Madsen, MD (*Boston, MA*),
Dawn Lathrop, RN (*Chicago, IL*)

Introduction: Extracranial CSF shunting to absorptive surfaces other than the peritoneum or cardiac atrium is unusual though sometimes necessary. The pressure dynamics of these types of shunts would be expected to differ from peritoneal or atrial shunting due to active pressure changes at the recipient sites. For instance, the pleura actively generates negative pressures while the gall bladder generates positive pressures.

Methods: We examined the in vivo intraventricular pressure (IVP) dynamics of ventriculopleural shunting (n=5), ventriculocholecystic shunting (n=1) and ventriculojugular shunting (n=1) utilizing a commercially available implantable telemonitor (Telesensor; Radionics, Burlington, MA). Patients were monitored telemetrically while supine and at increments of head elevation to 90 degrees.

Results: Ventriculopleural shunting resulted in persistent negative IVP at all levels of head elevation unless the shunt system contained an antisiphoning component, flow limiting valve (Orbis Sigma), or very high pressure differential valve. Ventriculocholecystic shunting mimicked peritoneal shunting dynamics except after a fatty meal, when pressures were elevated for several hours by approximately 5-10 cm of water. Shunting to the jugular vein in reverse orientation approximates the pressure dynamics of a stringent antisiphoning valve.

Conclusion: We conclude that ventriculopleural, ventriculocholecystic, and ventriculojugular shunts all have unique pressure dynamics specific to characteristics of each absorptive surface. Rather than simply as an alternative when peritoneal or atrial shunting is unavailable, these observations suggest that shunting to unusual absorptive surfaces may be appropriate for patients requiring specific intraventricular pressure dynamics (i.e., persistently negative or positive) in order to resolve their hydrocephalic symptoms.

Scientific Posters*

**Considered for Shulman Award*

1. The Combined Use of Hydroxyapatite Cement and Absorbable Plating for the Repair of Complex Cranial Defects

James Brennan, MD, Paul C. Francel, MD, W. David Min, MD
(Oklahoma City, OK)

Many modalities for repair of cranial defects in children have proven successful. Two of the newer technologies are hydroxyapatite cement and absorbable cranial plating systems. Single modality treatments of cranial defects is usually more than adequate for cosmesis. Two cases of complex defects were treated at our Children's hospital. In both cases the dura had pushed over the cranial defect edge and had become quite adherent to the bone. Placement of bone cement was not possible secondary to displacement by the pulsatile dura. The size of the cranial defects would not allow enough time for bone growth prior to resorption of the absorbable cranial plating system. In both cases a novel treatment plan was developed which involved the creation of a hydroxyapatite cement and absorbable plate construct to fill the cranial defect. It was felt that this would impede the pulsatile displacement of the cement and supply a matrix through which new bone growth could occur. Preliminary results have shown excellent results with no obvious complications. Further follow-up is required, but it appears that the combination of these treatments has increased the options available for the treatment of cranial defects in the pediatric population.

2. Use of Bioresorbable “Pop Rivets” and Plates in Pediatric Craniofacial Surgery: A New Fixation Technique

Paul Francel, MD, PhD, Kevin S. Smith, DDS (*Oklahoma City, OK*)

The use of LACTOSORB (Lorenz Surgical) bioabsorbable fixation system is well documented in the craniofacial literature. LACTOSORB is a compound polymer made of poly-L-lactic acid and polyglycolic acid. The advantages of resorbable fixation systems over conventional metallic systems are obvious. Metallic fixation systems require drilling a hole, tapping and placement of a buttressed thread screw. The purpose of this presentation is to describe a fixation technique that eliminates the use of the traditional drill/tap/screw method of fixation. We will review the use of a bioresorbable fixation system that uses a “pop-rivet” in replacement of the screw. Our craniofacial team has been using the bioresorbable fixation system routinely and we have found it to be faster, easier to use and safer. We will describe the advantages of this system as well as the clinical pearls learned with its use in pediatric craniofacial surgery.

3. WITHDRAWN

4. Extensive Oligodendroglia Proliferation in an Encephalocele

Boleslaw Liwnicz, MD, PhD, Y.Y. Ying (*Loma Linda, CA*)

It is frequently difficult to determine whether an ectopic glial tissue is a neoplasia, hamartoma or reactive tissue. We are presenting a case of reactive ectopic oligodendroglia tissue in an encephalocele.

A 36-week gestational age female was born to a Hispanic diabetic mother. The baby was microcephalic and had an 8x5x3 cm encephalocele. The occipital encephalocele was oval in shape and was attached to the intracranial brain by a narrow strip of tissue. It consisted of cerebral tissue covered by densely vascular tissue with astroglial reactive nests. The cerebral tissue showed cortical dysplasia surrounding a monotonous area of honeycomb densely cellular oligodendroglia cells. The cells were negative for GFAP and synaptophysin, confirming their oligodendroglial phenotype. Only a few nuclei were positive for Ki 67, indicating a very low proliferative index. The oligodendroglia cells were negative for P 53.

Reactive oligodendroglia proliferation was only recently described in experimental animals and some pathological processes, such as arteriovenous malformation. Small encephaloceles can be detected in later childhood or in adulthood as "ectopic gliomas". This appearance of ectopic glial tissue can be mistaken for an oligodendroglioma. A diagnosis of neoplasia instead of a reactive tissue can lead to improper therapeutic decisions.

5. Split Cord Malformation and Myelomeningocele. Report of Seven Cases

Santiago Portillo, MD, Adrian Fernandez, Carlos Moyano, Cesar Petre, Pedro Picco (*Buenos Aires, Argentina*)

The split cord malformation (SCM), as defined by Pang et al., comprises congenital defects (diastematomyelia, and diplomyelia), in which the spinal cord is divided by an bony or fibrous septum within a single dural sac, or into separate sacs. The incidence of this syndrome among patients suffering from myelomeningocele (MM), ranges from 5% to 36% in different series. The goal of this report is to present our experience in the management of patients with SCM and myelomeningocele regarding the mode of presentation, symptomatology, surgical findings, complications, and post-operative sequelae.

We evaluated 7 patients with myelomeningocele, and SCM admitted to our Institution between 1996 and 1998. The clinical presentation and symptomatology are described. The patients were studied with radiological examination of the spine, Magnetic Resonance Imaging (MRI), and Computerized Axial Tomography with 3D reconstruction. The surgical findings are described.

In 3 patients the diagnosis was made during MM closure, 3 patients presented symptoms related to SCM, and in 1 patient the diagnosis was made during a routine MRI. Five patients were classified as SCM type I, and 2 patients as SCM type II. One presented with both types of SCM. Pathologic examination revealed endodermic differentiation in two cases. One patient showed hemi-myelomeningocele. The complications were cerebrospinal fluid leakage in one case, and temporary worsening of motor strength in the lower extremities in another.

The results are discussed in the light of surgical findings. We comment on the usefulness of the different radiological studies, and on the planning of the surgical intervention. The surgical strategy is discussed, and the literature is reviewed. The results support the description of SCM by Pang et al.

6. Surgical Resection of Intraspinal Lipomas

Santiago Portillo, MD, Adrian Fernández, Carlos Moyano, Cesar Petre, Pedro Picco, (*Buenos Aires, Argentina*)

Intraspinal lipomas are a form of Spina Bifida Occulta. The proper time for surgical intervention, surgical strategy, and potential sequelae constitute a challenge, especially in those patients who are neurologically asymptomatic. We evaluated the clinical histories of 39 patients with intraspinal lipomas admitted to our institution between 1988 and 1997. We describe the symptomatology, neurodiagnostic, and neurophysiological studies. The surgical findings are reported and the long-term follow-up is analyzed.

Ages were between 1 month and 24 years. The most common clinical presentation corresponded to subcutaneous lipoma in the lumbosacral region. Forty six percent of the patients were asymptomatic at presentation. The remainder presented anomalies in motility of the lower extremities, urological function, or both. Twenty five percent had significant spine anomalies. On the basis of the relationship of the lesion observed during surgery, the lipomas were classified as: Transitional (61%), Dorsal (7%), Filum (23%), Transitional plus Filum (9%). The most frequent complication was cerebrospinal fluid leakage (15%). Transient worsening of motor function was observed in 1 patient. In 3 others, there was temporary worsening of urological function.

Conclusions: Despite the complexity of this pathology, surgery may be successful with regard to untethering of the spinal cord, without neurological or urological sequelae. We think that the surgical strategy benefits from the knowledge of the embryology of this developmental defect. Special care should be taken in the reconstruction of the dural sac during the closure in order to prevent an immediate CSF fistula or long-term complications such as retethering.

7. Surgical Treatment of Adult Spinal Lipoma by Loosening of the Responsible Spinal Nerve Roots and Conus

Yasuko Yoshida, MD, Reizo Shirane, MD (*Sendai, Japan*),
Takashi Ysohimoto, MD (*Sendai, Japan*)

Early prophylactic untethering surgery using modern neuroradiological evaluation and surgical techniques has achieved beneficial results in infants and patients in early childhood with asymptomatic spinal lipoma. However, the physiological differences in lumbosacral lesions between childhood and adult make untethering surgery more difficult and risky in adult patients with spinal lipoma and tethered cord syndrome. Therefore, the usual untethering procedure carries the risk of neurologic worsening in adult patients. We have adopted the developed surgical procedure for untethering. The risk of untethering the conus is judged based on the anatomic relationships or the degree of the postoperative scarring. In high risk cases, the thickened mesodermic tissue around the nerve roots and the conus is removed with debulking of the lipoma. Then the loosened nerve roots and spinal cord can be recognized in the surgical field with displacement of the conus. Retethering is prevented by reconstruction of the conus and extensive plasty of the dural sac using Gore-tex membrane with watertight closure. Twenty adult patients were surgically treated at our institute between 1990 and 1998. They were aged from 11 to 45 years (mean 22.2 years). Postoperatively, pain was improved in 6 patients and resolved in one. Motor symptoms improved in 9 patients, and neurogenic bladder dysfunction improved in 3. No new neurological deficit or deterioration occurred postoperatively. These clinical outcomes indicate that our principle for surgical treatment of adult spinal lipoma is more effective and safer than forced untethering.

8. Addition of Elemental Iodine to Surgical Irrigation for Neurosurgical Procedures

SooHo Choi, MD, J. Gordon McComb, MD, Michael L. Levy, MD,
Ignacio Gonzalez, MD, Berislav Zlokovic, MD (*Los Angeles, CA*)

Elemental iodine (I₂) has excellent ability to kill a broad spectrum of bacteria, fungi and viruses. Furthermore, bacterial resistance is unknown, and allergic reaction is rare. It is also extremely inexpensive.

Because of these properties and in an attempt to reduce our shunt infection rate, we have added elemental iodine at a concentration of 4 parts per million (ppm) to sterile Ringer's lactate, which is used to wash gloves and flush the shunt hardware just prior to implantation. Additionally, a solution of 2 ppm of iodine is used for wound irrigation. Despite this, shunt infections still remain problematic. Several studies have shown that by increasing the concentration of elemental iodine the exposure time needed to kill bacteria is reduced. Therefore, we wanted to ascertain the highest concentration of iodine that could be safely used as a surgical irrigant for direct application to the central nervous system.

Eighteen adult male Wistar rats (200-224 grams) consisting of six groups underwent a frontal-parietal craniectomy. Brains were then irrigated for one hour with Ringer's lactate alone or containing iodine at a concentration of 5, 10, 20, 100, or 1000 ppm. After 72 hours of observation, the animals were sacrificed. The brains were then fixed with formalin, stained with hematoxylin and eosin and then examined. At 5, 10, 20 and 100 ppm, there were no histologic changes noted. However at a concentration of 1000 ppm, severe necrosis was observed. Based upon these findings, we have subsequently increased the concentration of iodine in our hardware irrigation to 40 ppm and that of the wound irrigant to 20 ppm during shunt operations in hopes of decreasing our shunt infection rate.

9. Pediatric Neurosurgery Workforce: Results of a 1997 Survey

Ann Marie Flannery, MD (*Augusta, GA*)

Introduction: The availability of sufficient number of pediatric neurosurgeons is important to the well being of children. Evaluation of pediatric neurosurgeons' workloads, as well as plans for practice expansion, and retirement can help in workforce planning.

Materials and Methods: A survey was completed by attendees of the the 1997 AANS Pediatric Section Meeting in New Orleans, LA. One hundred fourteen surveys were returned with a response rate of 70%(69/94) for section members, 51%(30/59) for non-members, and 15%(15/45) for residents attending.

Results: Fifty-five percent of respondents (63/104) described their practice as academic. The median number of pediatric cases per year done by self-described academics was 200, for all other practice types; 150. However, the standard deviation was 95 and 112, respectively, a large variation. In practices described as "too busy", the median number of cases was 300. In practices described as "the right amount", the median number of cases was 200. In practices described as "not enough", the median number was 120. Thirty-nine respondents indicated a need for an additional pediatric neurosurgeon in the practice within the next 10 years and 18 reported planned retirement in the next 10 years.

Discussion/Conclusion: This survey was characterized by a good response rate among attendees at the meeting, and found a difference in workload between self-described academics vs. other practice types. Additional information includes initial benchmarks for case numbers in a practice, and the possible estimate of new and replacement pediatric neurosurgeons needed in the future.

10. Peroxynitrite Mediates Acute Cerebrovascular Inflammation Following Asphyxia in Neonatal Piglets

T. S. Park, MD, Jeffrey M. Gidday, PhD, Ernesto R. Gonzales, BSN,
Stuart S. Kaplan, MD (*St. Louis, MO*)

Objectives: Accumulating evidence indicates that leukocytes contribute to hypoxic-ischemic brain injury in the neonate, but the mechanisms by which this inflammatory response is initiated are not well understood. We tested the hypothesis that peroxynitrite is an important mediator of this response, secondary to the increased production of xanthine oxidase-derived superoxide radical following asphyxia.

Methods: In anesthetized newborn piglets equipped with closed cranial windows, we quantified rhodamine 6G-labeled leukocyte-endothelial adherence and adherence-dependent microvascular permeability to fluorescein in cortical pial venules by epifluorescent videomicroscopy. Statistical analysis was by paired and unpaired t-tests.

Results: We showed previously that transient severe hypoxia, hypotension, bradycardia and acidosis secondary to 9 min of asphyxia leads to a 6-fold increase in the number of leukocytes adherent to venular endothelium and a 2-fold increase in fluorescein leakage at 2 h of postasphyxic reperfusion (n=9) relative to matched controls (n=13) (*Am. J Physiol.* 272: H2622, 1997). Our new studies implicate superoxide radical in mediating this response since local window superfusion of superoxide dismutase or the C₃ carboxyfullerene isomer, a superoxide radical scavenger, decreased ischemia-induced leukocyte adherence and fluorescein permeability to control levels (n=9). Based on our findings that xanthine and uric acid concentrations measured in cortical microdialysis samples increased dramatically during postasphyxic reperfusion (n=7), and a dose-dependent attenuation of asphyxia-induced leukocyte adherence and fluorescein permeability resulted from administration of the xanthine oxidase inhibitor oxypurinol (n=6), we contend that superoxide radical was produced in large part by the activity of xanthine oxidase. Peroxynitrite may be the final mediator of these inflammatory responses, given both our previous observation that nitric oxide inhibition promotes leukocyte adherence in this model (*Stroke* 29: 1423, 1998), and our new finding that local superfusion of the peroxynitrite decomposition catalyst Fe-TMPS (*Proc. Nat Acad. Sci.* 95: 2659, 1998) blocked these asphyxia-induced inflammatory events (n=7).

Conclusions: These findings indicate that the acute cerebrovascular leukocyte adherence and associated blood-brain barrier breakdown occurring in asphyxiated piglets is mediated by peroxynitrite secondary to the xanthine oxidase-driven production of superoxide radical.

11. Pediatric Patients with Spinal Cord Compromise Due to Complications of Proteus Syndrome

Heather Halpin Richardson, Ann Marie Flannery, MD, Mark Lee, MD, PhD,
Michael Cowan, MD (*Augusta, GA*)

Purpose: Proteus syndrome is a rare condition diagnosed in children that is manifest by hamartomatous neoplasms, most commonly lipomas, hemangiomas, and lymphangiomas. Awareness of potential spinal cord compromise is important to avoid irreversible neurological deficits.

Materials and Methods: Nine cases of Proteus syndrome with spinal canal involvement are reported, two of which were assessed and treated by the authors. Three patterns of disease are noted. In two cases, intraspinal lesions were lymphangioliipomas. In three cases the tumor was a more vascular angioliipoma. The third pattern consisted of canal stenosis secondary to severe bony abnormalities which comprised the remaining four cases.

Discussion: Although Proteus syndrome is not frequently encountered, affected patients can present with a variety of lesions causing spinal cord compression.

Conclusion: Patients with Proteus syndrome should be evaluated by MRI for the presence of intraspinal lesions, and if found, these masses should be excised. Vascular masses may require pre-surgical embolization to decrease operative complications.

12. Perioperative Complications and Blood Transfusion Requirement for Adolescent Scoliosis Surgery

Gregory Wiggins, MD, Christopher Shaffrey, MD, Michael Rauzzino, MD
(*Detroit, MI*)

Surgical treatment for scoliosis is a significant procedure that carries potential for large blood loss and severe complications. We prospectively tabulated the complications and need for blood transfusion in 9 patients average age 14.1 years (11.2-19.2) undergoing 11 operations for progressive scoliosis. One patient had anterior Isola instrumentation, one had anterior and posterior instrumentation and the rest received posterior segmental instrumentation using the C-D Horizon system. One patient had scoliosis secondary to neurofibromatosis, another secondary to Angelman's syndrome and the remainder were idiopathic. Surgery was performed between December 1997 and July 1998 with a short follow-up (average 8.9 months) which is ongoing. Instrumentation was performed on an average of 8.4 levels (3-14). Operative time averaged 325 minutes (205-447). Average blood loss was 627 ml (250-1100) and 84 ml per level. Blood replacement averaged 414 ml (0-800). All blood products were autologous or directed donation. The preoperative Cobb angle averaged 64 degrees (42-81) and the postoperative Cobb angle averaged 31 degrees (18-46) with 51 percent average correction. Complications in this series included one patient with inferior hook displacement requiring revision. Another patient with King II thoracolumbar scoliosis developed progression of her lumbar curve after T1-T12 instrumentation. Her construct was extended to L4 and since has done well. No case was complicated by neurological deterioration, loss of SSEP's, cardio-pulmonary disease, infection, donor site complication or wound breakdown. Compared with other major operations, segmental instrumentation for adolescent scoliosis is a safe procedure with minimal morbidity and low risk of allogeneic blood products.

13. TGF-Beta1 Expression is Decreased in H-Tx Rat Brains of Hydrocephalus

Xingang Cai, MD, Jogi Pattisapu, MD, Jane Gibson, PhD, Roy Tarnuzzer, PhD
(Gainesville, FL), Christina Fernandez-Valle, PhD

Transforming growth factor-Beta1 (TGF-Beta1) is a cytokine with diverse biological effects. Overexpression of TGF-Beta1 in mice has been shown to induce hydrocephalus. To further understand the role of TGF-Beta1 in the pathogenesis of hydrocephalus, we have studied TGF-Beta1 expression in brains of H-Tx, a rat model of hydrocephalus. Total RNA was isolated from brains of 3-day (n=4 in each group), 10-day (n= 3 in each group) and 3-week (n=4 in each group) old phenotypically normal and hydrocephalic H-Tx rats and from normal Sprague-Dawley (SD) rats. TGF-Beta1 was amplified from isolated RNA by a quantitative RT-PCR using a competitive TGF-Beta1 template. The amplicons were quantitated using the NIH-Image program. The results showed that in 3- and 10-day age groups, TGF-Beta1 expression was significantly lower in hydrocephalic H-Tx rats than their normal siblings ($P<0.01$) and this difference becomes insignificant in 21-day group ($P>0.05$). When compared to SD rats, both hydrocephalic and normal H-Tx rats have significant lower TGF-Beta1 expressions in all three age groups ($P<0.01$ in all three groups). The expression changes with age have also been analyzed. In SD group, the expression levels tend to go down but fail to show statistical significance while in both hydrocephalic and normal H-Tx groups, there is some restoration of the TGF-Beta1 expression, especially in the 21-day old group ($P<0.01$ in both groups). Our data indicated that TGF-Beta1 expression is decreased rather than increased in the brains of H-Tx rat, a commonly used hydrocephalus model.

14. Studies of Brain Water in Hydrocephalic and Normal H-Tx Rats

Xingang Cai, MD, Glenda McGraw, Jogi Pattisapu MD, Jane Gibson, PhD

The genetic pattern of the H-Tx hydrocephalus rat model is presumed polygenic, and the genetic abnormality responsible for the disease has not been identified. To better understand the pathogenesis of the disease, we have studied the brain water content at different ages.

Methods: Three groups of rats, including hydrocephalic (Hc) H-Tx rats, their normal littermates and normal Sprague-Dawley (SD) rats were studied. Each group contained two different age groups (3- and 21- day) (n= 5 to 15 in each age group). After decapitation, the brains were removed and weighed (wet weight). The brains were dried completely and weighed again (dry weight). The water contents were calculated based on the difference between wet and dry brain weights.

Results: In 3-day groups, brain water is higher in Hc rats (87.91 ± 0.32) than their littermates (87.26 ± 0.25 , $P < 0.01$) and SD rats (86.98 ± 0.27 , $P < 0.01$). The normal H-Tx rats also have higher brain water than the SD controls ($P < 0.05$). In 21-day group, the difference between the normal H-Tx rat and the SD rat becomes non-significant ($P > 0.05$) but the Hc rats still have higher brain water than other two groups ($P < 0.01$ in both groups).

Conclusion: Our data suggested that the H-Tx rats, whether Hc or normal, have higher brain water content than SD rats, especially in young rats.

15. Low Pressure Shunt Malfunction Following Lumbar Puncture in Two Children with Shunted Obstructive Hydrocephalus

Mark Dias, MD, Veetai Li, MD, John Pollina, MD (*Buffalo, NY*)

We encountered two patients with shunted obstructive hydrocephalus, both having medium pressure valves (opening pressure 8-12 cm water). Both developed severe headaches and ventricular enlargement in comparison with baseline CT scans following a lumbar puncture (LP). A prominent and unusual feature of the headaches in both children was that they were worsened by the upright posture and relieved with recumbancy, suggesting low pressure headaches. Shunt taps in both children performed during the headaches and in a recumbent position showed excellent proximal flow and opening pressures of 6 and 8 cm water, respectively. Both were treated with bedrest, and became asymptomatic within 24 hours. Follow-up CT performed 1 and 3 days after presentation showed the ventricles had returned to their baseline size. Neither child required a shunt revision.

We postulate that CSF leakage from the lumbar theca following LP reduced the global intracranial pressure to a point beneath the opening pressure of their valves. The ventricular CSF, unable to communicate with the subarachnoid space and unable to drain through the shunt because of low intracranial pressures, accumulated and produced ventricular enlargement. Pang and Altschuler (1994) previously described 12 patients with shunted hydrocephalus and a 'low pressure hydrocephalic state' presumed to be due to increasing ventricular volume in a brain having unusually high compliance, for which they recommended prolonged, low pressure external drainage. The low pressure hydrocephalic state in two of their patients developed after LP, and may have had a problem similar to our two children. It is important to recognize this entity, as the treatment is not shunt revision, but rather enforced bedrest or a blood patch.

16. Prognostic Factors for Childhood Intracranial Ependymomas

Kenneth Liu, BA, Wesley Miao, BA, Arun Amar, MD, Lena Masri, MS, Michal Levy, MD, J. Gordon McComb, MD (*Los Angeles, CA*)

Objective: Ependymomas comprise 5 to 10% of pediatric brain tumors. Despite their frequency, consensus is currently lacking regarding the demographic and therapeutic factors that predict a favorable outcome. Therefore, we performed a retrospective analysis of 27 patients treated in the MRI and CT era at a large pediatric referral center.

Methods: All patients undergoing resection of an intracranial ependymoma from 1984 to 1997 were included. The Kaplan Meier product-limit method was used to construct survival distribution curves as a function of several variables that have been suggested to be relevant in the pre-existing literature. The effects of age (< or > than 3 years), duration of preoperative symptoms (< or > than 1 month), extent of surgical resection (gross total vs. subtotal), location (supra- vs. infra-tentorial), and the use of adjuvant therapies (chemotherapy or XRT) were all compared using the log rank test. Chi-square analysis was also used to compare contingency tables derived from the dichotomous outcome variables of mortality and the need for ventriculoperitoneal shunting.

Results: Patient survival ranged from 1 to 170+ months for the study as a whole. Of the prognostic and therapeutic factors that were tested, only the extent of surgical resection achieved marginal significance in both types of analysis ($p=.0545$), while the patient's age, duration of preoperative symptoms, tumor location, and exposure to adjuvant therapy failed to demonstrate any statistically significant effects on survival distribution.

Conclusions: While this study does not uphold the validity of some prognostic factors reported in the literature, it confirms the extent of resection as an important predictor of survival in children with intracranial ependymomas. However, multicenter trials are necessary to accrue a sufficient number of patients before making definitive treatment recommendations.

17. Evaluation of Imaging Modalities for Diagnosis of Hydrocephalic Rats

Benjamin Peltesen, Katie Pan, Glenda McGraw, Sue Willingham, Xingang Cai, MD, Jogi Pattisapu, MD

We attempted to define a severity scale and evaluate the degree of hydrocephalus in the H-Tx rat model. Ultrasound, CAT scan and MRI imaging techniques were compared with gross pathology in animals of various age groups.

Methods: 70 H-Tx rats were divided into four age groups (4, 10, 15, and 21 days), and 4 animals were studied longitudinally at the same data points. The rats were phenotypically diagnosed with hydrocephalus and graded using a severity scale (0-none to 3-severe). After examination by the 3 imaging modalities, the animals were sacrificed and gross pathological evaluation was undertaken. The gross anatomic data was compared with the results of the various imaging techniques. We tabulated the accuracy and compared the different imaging modalities.

Results: CT scanning provided the most reliable correlation of ventricular size in this study. MRI results were inconclusive due to the immaturity of the brain, and ultrasound studies were difficult after 10 days of age.

Discussion: Imaging studies can be effectively performed *in vivo* to verify diagnosis and document adequate treatment in the H-Tx hydrocephalic rat.

18. Endoscopic-Guided Proximal Catheter Placement in Treatment of Posterior Fossa Cysts

David Sandberg, MD, Mark M. Souweidane, MD (*New York, NY*)

Introduction: Treatment of posterior fossa cysts by cystoperitoneal shunting may be complicated by a malpositioned catheter located within the brainstem or cerebellum causing shunt malfunction or neurological deficits. We propose that catheter placement from a posterior fossa approach aided by a malleable endoscope may prevent malposition and its complications.

Methods and Results: Three patients underwent cystoperitoneal shunting for symptomatic posterior fossa cysts: 1. A 7 month old female presented with obstructive hydrocephalus and a large posterior fossa cyst. Ventriculoperitoneal shunting was performed. Postoperative MRI demonstrated enlargement of the posterior fossa cyst. 2. A premature male with postinfectious/compartmentalized hydrocephalus underwent ventriculoperitoneal shunting. Postoperative imaging revealed an isolated fourth ventricle with mass effect. 3. A 66 year old male presented with headache, gait disturbance, dysphagia, and nystagmus. MRI revealed a retrocerebellar arachnoid cyst compressing the cerebellum and brainstem.

In each case, a pre-incised ventricular catheter was placed over a 1.1 mm endoscope (Clarus Medical Systems; Minneapolis, Minn.). The catheter and endoscope were molded to obtain an appropriate trajectory for a posterior fossa approach. Visualization of the cyst wall during catheter placement insured an intracavitary position. Postoperative imaging confirmed a well-positioned catheter with an incremental decrease of cyst size.

Discussion: A small caliber malleable endoscope can provide direct visualization of proximal catheter position when treating posterior fossa cysts with cystoperitoneal shunts. Molding of the catheter and endoscope enables the surgeon to direct the catheter in the appropriate trajectory. Further investigation with a larger patient population will determine if endoscopic placement can decrease the frequency of catheter malpositioning.

19. Evaluation of Shunt Malfunction Using Shunt Site Reservoir

Sandeep Sood, MD, Alexa I. Canady, MD, Steven D. Ham, DO
(*Detroit, MI*)

Objective: To determine if a ventricular reservoir placed at the site of the shunt remains patent in the event of a shunt malfunction and assess its usefulness in evaluation of a shunt malfunction.

Methods: Ventricular catheter was placed alongside the proximal catheter of the shunt and connected to a subgaleal reservoir in 13 patients at the time of shunt revision. At presentation of suspected shunt malfunction, the reservoir and the shunt valve were tapped and opening pressure and flow was recorded. In the event patient underwent a shunt revision, the opening pressure, status of the proximal shunt catheter and the reservoir catheter was documented.

Results: Seven patients subsequently presented with symptoms suggesting a shunt malfunction at a mean interval of 16.2 days (SD, 21.9 days) after shunt revision. A shunt tap in all seven revealed no or equivocal flow, however, a reservoir tap showed a high opening pressure in all and in two patients who had presented in extremis with bradycardia, allowed ventricular decompression. The opening pressure recorded from the reservoir corresponded with the opening pressure obtained at surgery in each case. The reservoir and ventricular shunt catheter examination at the time of surgery showed ventricular shunt catheter was plugged with debris or tissue while the reservoir shunt catheter was clean.

Conclusion: This study suggests that reservoir placed at the site of a shunt may remain patent even when the shunt malfunctions and may be an aid in diagnosis of a shunt malfunction and allow early ventricular decompression in a sick patient while waiting for surgery for shunt revision. Although the numbers are small, this study justifies continued collection of data for a larger series.

20. MRI Artifact Mimicking a Temporal Lobe Lesion in an Epilepsy Patient

Praveen Mummaneni, MD, Warwick J. Peacock, MD (*San Francisco, CA*)

A ten year old healthy child presented with a new onset right upper extremity focal seizure which became generalized. She was neurologically intact on examination and had no risk factors for seizures. An MRI was performed and revealed a one centimeter area of decreased signal intensity in the left posterior temporal gray-white junction on multiple sequences which was interpreted by the radiologist as either a migrational anomaly or a DNET. In addition, the MRI also displayed a two centimeter lesion on the patient's nasion. As the lesion on the nasion did not correlate with the patient's physical exam we elected to delay biopsy of the left temporal lesion and repeat the MRI on a different scanner. The repeat MRI revealed no intracranial or extracranial pathology. This case represents a malfunctioning MRI scanner which created an artifact that mimicked a temporal lobe tumor in an epilepsy patient. The physics of MRI are reviewed as they pertain to this artifact.

21. Magnetic Source Imaging as a Preoperative Diagnostic Tool

Ronald Young II, MD, James E. Baumgartner, MD

Magnetic source imaging can be a valuable tool in the preoperative planning of resections of tumors or seizure foci in or adjacent to eloquent cortex. With the ability to record neuronal activity and record spontaneous phenomena this imaging method has distinct advantages over both fMRI and PET. A review of 10 patients demonstrates the high level of both spatial and temporal resolution of this technique as well as functional correlation with intraoperative electrocorticography.

22. Mobilizing the Umbilicus for Optimal Placement of a Baclofen Pump

Michael Handler, MD, FACS, FAAP

An intrathecal infusion of baclofen from an implanted pump is an increasingly accepted treatment of chronic spasticity in cerebral palsy, trauma, and other conditions. However, it may be difficult to place the pump away from bony prominences in children who are small, or restraining bars or straps in children confined to complex wheelchairs. Unfortunate placement may lead to wound breakdown, skin erosion, pocket infections or meningitis. The area available to place a pump safely may be increased significantly by separating the skin at the umbilicus from the underlying rectus and umbilical fascia, to allow a more central location. The technique has been used safely in three children, and will be described in detail. Care must be used to avoid violating the skin at the base of the umbilicus, and to place ports of the pump away from areas that will be difficult to clean when it is accessed.

23. Evaluation of Intrathecal Drug Infusion Pump Function

Michael Turner, MD

The Medtronic drug delivery pump has become widely used in Pediatric Neurosurgery for intrathecal baclofen administration in intractible spasticity. Patients will inevitably develop loss of control and the drug delivery system must be evaluated to determine the cause. An algorithm for evaluation of the patient with loss of control of spasticity will be presented based on ten years of experience with the Medtronic infusion system. The radioisotope pump function study will be described as well as a review of other catheter function studies.

24. Television Set Head Injuries in Children

Jeremy Denning, MS4, James Baumgartner, Ron Young, III, MD,
Linda Ewing-Cobb (*Houston, TX*)

Each year there are 22,000 emergency room visits for injuries involving home television sets, with children sustaining most of these injuries. Crush type head injuries to children from accidental falling televisions can occur in this setting. This type of injury is caused by static loading forces applied to the cranium, as opposed to the more common dynamic forces involved in rapid deceleration injuries.

Five cases of television set head injuries in children presented to our institution from 1996-98. Patient ages ranged from 2 to 5 years. Four patients experienced at least skull base fractures with a loss of consciousness. One patient experienced a depressed skull fracture with an acute subdural hematoma, as well as, fractures involving both orbits and the clivus. Management ranged from overnight observation to craniotomy with prolonged ICP management. Severity of injury was related to the size of the television screen. All patients survived without gross neurologic deficit. Neuropsychological outcome will be discussed.

Large screen televisions represent a significant health risk to small children. Televisions should be secured in households with small children.

25. Children Killing Children: Treating the Spreading Epidemic

Mimi Sutherland, RN, MS, CNRN, Phil Aldana, MD, David Petrin, RN, Dan Frank, MD, John Ragheb, MD (*Miami, FL*)

The killing fields for children have extended from the inner cities to small town America, suburbia and schoolyards. Adults who armed themselves to protect their families are finding that their children are indeed at far greater risk from the family handgun. Educating children in the sterile classroom format to just say no to guns as the singular remedy is unrealistic. The Public Health approach to the epidemic is more effective using a strategic scientific plan which encompasses the tested injury prevention concepts of education, engineering and enforcement applied to the injury prevention triangle: the agent (firearm), the host (shooter) and the environment (community).

Adults need to be convinced that they are responsible and accountable for securing their weapons and preventing child gun access. Parents who provide their children with toy guns and encourage gun play behaviors must realize how difficult it is for their child to transition from play behaviors to threatening situations in the saturated gun culture of our society. There are no gun accidents. Intentional and unintentional injuries are more appropriate descriptors.

A review of 379 pediatric firearm injuries and deaths were reviewed from 1992-1997. The incidence patterns facilitated the development of an educational program for both parents and children and defined the geographic program implementation needs. High risk variables as predictors of firearm injury were determined for specific populations and enabled the prevention program to be ethnically and culturally specific. A brief video validates and depicts ingenious child attraction and access to firearms. The gun safety education program will be demonstrated.

26. Juvenile Pilocytic Astrocytoma in Infants. Columbus Children's Hospital Experience

Philip Hodge, MD, Edward J Kosnik, MD (*Columbus, OH*)

Introduction: The experience of Children's Hospital of Columbus, Ohio was examined to determine the role of histologic diagnosis of juvenile pilocytic astrocytoma in the outcome of infants.

Methods: Medical, pathologic, and imaging data was reviewed for twenty-six patients (ranging from 3 months to 24 months) with juvenile pilocytic astrocytoma treated between 1958 and present. Patients were treated with surgery with or without chemotherapy and radiation.

Results: The overall survival rate was 61.5% (16/26), with a median age of onset of 15 months and median follow-up of 82.5 months. Location was a good prognostic factor as there were no deaths in those with cerebellar or spinal cord occurrences. The histologic characteristics of increased apoptosis suggested a more aggressive tumor although this did not affect survival.

Conclusion: Juvenile pilocytic astrocytoma has distinctive histologic characteristics in this age group yet still has a favorable outcome.

27. MRI Assessment of Spinal Cord Movement

Robert R. C. Jones, MD, John Pereira

Following operative release of a tethered spinal cord the static MRI often appears unchanged. Clinically deterioration may occur slowly. Also some bands are not easily visualised. In an endeavour to assess both the presence of tethering and to quantitate tethering, phase contrast MRI measurements were performed on 57 children who were scheduled for MRI of their dysraphic spines. Ten children with a clearly normal cord provided control data, Another group of 12 children had signs of cord pathology with a normal static MRI. The total spinal cord velocity was calculated by adding the maximum positive and negative values during the cardiac cycle.

Controls	Normal MRI & Signs	Thick filum or band		Lipoma Cauda Equina		Open Myelomeningocele		Syrinx Chiari		
		Worse/Stable	Worse/Stable	Worse/Stable	Worse/Stable	1	2			
No.	10	12	2	21	1	13	4	13	2	2
			Cord Velocity cm/s							
Mean	0.90	0.36	0.35	0.61	0.18	0.55	0.55	0.51	0.43	0.51
Min.	0.50-	0.28-	0.26-	0.33-		0.30-	0.25-	0.15-	0.38-	0.48-
Max	-1.23	-0.48	-0.43	-1.10		-0.78	-1.04	-1.02	-0.48	-0.54

In the normal waveform, the cord movement was opposite to the CSF. In the dysraphic group, a biphasic cord waveform was often seen. Contamination of cord signal with CSF signal occurred in 4 excluded cases.

Phase contact MRI promises useful information at little extra cost. It provides an objective assessment of cord mobility as a result of surgery. A low cord velocity should prompt closer examination for unusual cause of cord tethering.

28. Unusually Rapid Growth of Subependymal Giant Cell Astrocytoma

Azedine Medhkour, MD, Charles Teo, MD, Charles M. Glasier, MD
(*Little Rock, AR*)

Objective and Importance: Subependymal giant cell astrocytoma is usually a benign, slow growing glial tumor that manifests with signs and symptoms of obstructive hydrocephalus in patients with tuberous sclerosis (TS). It is uncommon for these periventricular tumors to rapidly develop into giant intracranial mass lesions within weeks of diagnosis, leading to neurological deterioration and death.

Clinical Presentation: We report a 5 months old boy with TS whose head CT at 7 weeks disclosed a 3.5X3cm cystic mass lesion in the left frontal lobe as well as multiple other periventricular masses. He was treated conservatively, however a few weeks later he was readmitted with intractable seizures, massive increase of the left frontal tumor and obstructive hydrocephalus.

Resection of the left frontal mass was carried out. The tumor was highly vascular, cystic, and necrotic in certain areas, but did not lose its benign character. Despite a repeat debulking of a second lesion in the right frontal lobe, the patient succumbed to his multiple massive tumors.

Conclusion: Highly aggressive subependymal giant cell astrocytomas are uncommon, their biological behavior may be related to a genetic alteration that remains to be determined. We report this case and review the literature.

29. Ganglion Cell Tumor of the Cerebellum with Extensive Involvement of the Cervicothoracic Spinal Cord

Renatta J. Osterdock, MD, Liliana C. Goumnerova, MD (*Boston, MA*)

Objective and Importance: We present the clinical, radiologic, and histopathologic features of a rare case of ganglion cell tumor with extensive contiguous cerebellar and cervicothoracic spinal cord involvement.

Clinical Presentation: A 14 month old female presented with a 2 week history of irritability and vomiting progressing to lethargy 48-72 hours prior to admission.

Intervention: MRI demonstrated a large tumor involving the cerebellar hemisphere as well as the cervicothoracic spinal cord to the T4 level. A midline posterior fossa approach allowed significant debulking of the cerebellar mass but the lesion became indiscernible from normal tissue at the level of the fourth ventricle. There was diffuse expansion of the spinal cord and the intraspinal component could not be distinguished from normal spinal cord. Histopathology revealed a ganglion cell tumor and distinction between ganglioglioma and gangliocytoma was difficult. Post-operatively, the patient did well with resolution of her preoperative symptoms.

Conclusion: Ganglion cell tumors represent a spectrum of neuropathologic diagnoses which have been described in locations throughout the CNS and with activity ranging from an aggressive clinical course to incidental findings on autopsy. Due to the unpredictable nature of these lesions, as well as the difficulties encountered in precise diagnosis, close neurologic and radiologic follow-up is warranted.

30. In Vitro Cytotoxicity of Phenylacetate in Human Medulloblastoma Cell Lines

Tomoko Ozawa, MD, PhD, Lily Hu, MS, Michael D. Prados, MD, Dennis F. Deen, PhD (*San Francisco, CA*)

Introduction: Phenylacetate (PA) inhibits the growth of tumor cells and shows promise as a relatively non-toxic drug for cancer treatment. A recent report showed that PA can enhance the radiation response of a human prostate carcinoma cells (Miller et al. *Int. J. Radiat. Biol.* 72:211-218, 1997), opening up the possibility of using this drug to improve the radiation therapy of cancer.

Methods: We investigated PA-induced growth inhibition and colony forming efficiency in human medulloblastoma Masden and Daoy cells. We also studied the cytotoxicity produced by PA in combination with X-rays.

Results: Daoy cells were slightly more sensitive than Masden cells to PA. It required 10 mM PA to inhibit Masden cell growth, a concentration that did not affect cell survival. In contrast, 10 mM PA inhibited cell growth and killed ~50% of cells. Exposure of both medulloblastoma cell lines to non-toxic treatments with 5 mM PA for 1, 3, and 5 days did not enhance the subsequent cell killing produced by X irradiation. However, enhanced cell killing was achieved by exposing cells to drug concentrations >70 mM for 1 h immediately before X-irradiation.

Conclusions: PA can inhibit the growth of medulloblastoma cells. However, non-toxic PA treatments did not enhance the radiation response of these cells. These results are similar to those obtained by us earlier using SF-767 human glioblastoma cells, which also required toxic drug treatments to enhance radiation response. It remains to be determined whether these relatively high drug concentrations are achievable in vivo.

31. A Case of Supratentorial Dermoid Tumour

Ishwar Chandra Premsagar, MD, A.K. Srivastava, MD

Intracranial dermoids constitute a small group of pediatric tumours. They are rare in supratentorial compartment.

We are presenting a case of right frontotemporobasal dermoid tumour who presented as seizures. A 16 year old boy resident of Northern India complained of grand mal seizures of 7 years duration. Examination was essentially normal. In significant family history elder brother of patient died at the age of 9 years in 1991, He developed high fever followed by repeated seizures and died within hours. The cause of death is not known as autopsy was not performed.

CT/MRI head showed discrete hypoattenuating (Hounsfield Vaule = -19) in right basifrontal region extending into temporal region.

Suprasellar cistern was not deformed. Capsular Calcification was seen. On operation by right pterional approach the capsule and contents were removed piece meal. Buttery material mixed with white hairs was removed. Post operative CT showed total excision.

Standard neurosurgical textbooks do not mention about frontal or temporal dermoid tumours. However Yasargil (1989) & Bucchiero (1995) have reported 7 cases(2FB, 3TB, 1FT) & 5 Cases(2FB, 1TB, 2FT) respectively.

The pre and post operative imaging & operative photographs will be displayed.

* FB - Frontobasal

TB - Temporobasal

FT - Frontotemporobasal

32. Sickle Cell Disease and Moyamoya Syndrome Treated with Encephaloduroarteriosynangiosis

Robert E. Tibbs, Jr., MD, Adam I. Lewis, MD (*Jackson, MS*)

New Improvements in the medical treatment of sickle cell disease have allowed patients to live longer. One by-product of this longevity is the development of moyamoya syndrome. Only one case of revascularization for sickle cell disease and moyamoya syndrome has been reported. We report the second case of encephaloduroarteriosynangiosis (EDAS) in a six-year-old boy with sickle cell disease who presented with a right frontal stroke, progressive headaches, and poor school performance. Cerebral angiography demonstrated bilateral terminal internal carotid artery and middle cerebral artery stenoses. A single-photon emission computed tomography (SPECT) scan showed hypometabolism of the frontal lobes. Neuropsychological testing showed cognitive deficiencies in all areas except reading. The patient underwent bilateral staged EDAS over one month and recovered without incident. After surgery, headaches resolved and school performance improved. There have been no further strokes or ischemic episodes. The postoperative cerebral angiogram showed excellent revascularization of the middle cerebral artery territories. The postoperative SPECT scan showed increased cerebral perfusion in both hemispheres. Repeat neuropsychological testing showed cognitive improvement. The presence of sickle cell disease in moyamoya syndrome might not be a contraindication to revascularization. We recommend a prospective, randomized, multicenter study to determine the benefit of indirect revascularization in this group of patients.

33. The Occurrence of Congenital Pediatric Aneurysms

Robert Tibbs, MD, Kevin R. Killough, MD (*Jackson, MS*); John A. Lancon, MD (*Dallas, TX*); Adam I. Lewis (*Jackson, MS*); Andrew D. Parent, MD (*Jackson, MS*)

Most experts agree that cerebral aneurysms are not congenital lesions. Pediatric cerebral aneurysms are usually a consequent of infection, trauma, collagen vascular diseases, and hemodynamic stresses from systemic disorders such as coarctation of the aorta or polycystic kidney disease. We present a 6-year-old boy with several vertebral artery aneurysms that appeared congenital in origin. The child had been healthy and had no history of infection, trauma, cardiac anomalies, or collagen vascular diseases. The family history was negative for cerebral aneurysms. The boy suffered two subarachnoid hemorrhages three days apart. A computed tomographic scan showed Fisher Grade III subarachnoid hemorrhage. The cerebral angiogram demonstrated several aneurysms along the left vertebral artery from its intracranial origin to the vertebrobasilar junction. The left anterior inferior cerebellar artery supplied its anticipated territory and the territory of the left posterior inferior cerebellar artery. A suboccipital craniotomy and far lateral approach were performed to trap the left vertebral artery. Intraoperative angiography confirmed complete obliteration of the vertebral artery aneurysms. Postoperatively, there were no neurologic deficits. The coexistence of a complex aneurysm of the left vertebral artery and anomalous posterior circulation arterial pattern suggests a congenital origin. The embryological development of the vertebrobasilar artery as it pertains to the development of congenital aneurysms will be reviewed.

**The American Association of
Neurological Surgeons
and
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**Section on
Pediatric Neurological Surgery**

Membership Roster

Abbasy, Munir H., MD
80 Congress St.
Springfield, MA 01104-3427
Active Member

Abbott, Ira R., III MD
Beth Israel Med. Ctr.
170 E. End Ave./Neuro.
New York, NY 10128
Active Member

Adelson, P. David, MD
Children's Hosp. of Pittsburgh
3705 Fifth Ave./Neurosurgery
Pittsburgh, PA 15213-2583
Active Member

Albright, A. Leland, MD
Children's Hosp. Pittsburgh
3705 5th Ave./Neurosurgery
Pittsburgh, PA 15213-2524
Active Member

Altenau, Lance, MD
501 Washington
Suite #700
San Diego, CA 92103-2231
Active Member

Amacher, A. Loren, MD
Geisinger Clinic
Dept. of Neurosurgery
Danville, PA 17822-0001
Active Member

Amador, Luis V., MD
1440 Veteran Ave., #336
Los Angeles, CA 90024-4832
Lifetime Member

Ammar, Ahmed S., MD PhD
KFHU/Neuro.
P.O. Box 40040
Al-Khobar, 31952
Saudi Arabia
International Member

Anderson, Jim D., MD
P.O. Box 658
San Carlos, CA 94070
Lifetime Member

Andrews, Brian T., MD
UCSF/Dept. of Neurosurgery
2100 Webster St., Suite #521
San Francisco, CA 94115-2382
Active Member

Arkins, Thomas J., MD
Connecticut Neurosurgery, PC
60 Temple St., #5B
New Haven, CT 06510
Active Member

Aronin, Patricia A., MD
4314 Medical Pkwy.
Suite #201
Austin, TX 78756
Active Member

Arpin, Elaine J., MD
S.W. Florida Neuro. Assoc.
413 Del Prado Blvd., Suite #102
Cape Coral, FL 33990-5710
Active Member

Baeesa, Saleh S. A., MD
King Abdulaziz Univ. Hosp.
P.O. Box 6615
Jeddah, 21452
Saudi Arabia
Active Member

Bailey, Walter L., MD
Doctors' Professional Bldg.
280 N. Smith Ave., Suite #234
St. Paul, MN 55102-2420
Active Member

Balis, Gene A., MD
3000 E. Fletcher Ave.
Suite #340
Tampa, FL 33613-4645
Active Member

Barrer, Steven J., MD
1584 Old York Rd.
Abington, PA 19001-1709
Active Member

Bartkowski, Henry M., MD PhD
Neurological Assoc.
931 Chatham Ln.
Columbus, OH 43221-2486
Active Member

Baumgartner, James E., MD
6410 Fannin
Suite #1400
Houston, TX 77030
Active Member

Beatty, Robert M., MD
8919 Parallel Pkwy.
Suite #455
Kansas City, KS 66112-1655
Active Member

Bell, William O., MD
Carolina Neuro. Assoc., PA
2810 Maplewood Ave.
Winston-Salem, NC 27103-4138
Active Member

Benzel, Edward C., MD
Univ. of New Mexico
Div. of Neurosurgery
Albuquerque, NM 87131
Active Member

Berger, Mitchel S., MD
UCSF/Neurosurgery
505 Parnassus, Room M-787
San Francisco, CA 94143-0112
Active Member

Berger, Thomas S., MD
Mayfield Clinic
506 Oak St.
Cincinnati, OH 45219-2507
Active Member

Bierbrauer, Karin S., MD
St. Christopher's Hosp.
Erie & Front St./Ped. Neuro.
Philadelphia, PA 19134
Active Member

Black, Peter McL., MD PhD
Children's Hosp./Neuro.
300 Longwood Ave.
Boston, MA 02115
Active Member

Blount, Jeffrey P., MD
Naval Med. Ctr., Code 42DGA
34800 Bob Wilson Dr./Neurosci.
San Diego, CA 92134-5000
Active Member

Boggs, John Scott, MD
1820 Barrs St.
Suite #104
Jacksonville, FL 32204-4742
Active Member

Boop, Frederick A., MD
9601 Lile Dr.
Suite #750
Little Rock, AR 72205
Active Member

Boydston, William R., MD
5455 Meridian Mark Rd.
Suite #540
Atlanta, GA 30342-1640
Active Member

Bressler, Bruce C., MD
720 S. Van Buren
Green Bay, WI 54301-3538
Active Member

Brockmeyer, Douglas L., MD
Primary Children's Med. Ctr.
100 N. Medical Dr., Ste. #2400
Salt Lake City, UT 84113-1100
Active Member

Brown, Jeffrey Alan, MD
Med. Coll. of Ohio/Neurosurg.
3065 Arlington Avenue
Toledo, OH 43614
Active Member

Bruce, Derek A., MD
Neurosurgeons for Children
7777 Forest Ln., B308
Dallas, TX 75230
Active Member

Buchheit, William A., MD
1015 Chestnut St.
Suite #1400
Philadelphia, PA 19107
Active Member

Burke, Michael James, MD
Neurological Clinic
3006 S. Alameda St.
Corpus Christi, TX 78404-2601
Active Member

Cahan, Leslie D., MD
1505 N. Edgemont St.
Neurosurgery/Room #4141
Los Angeles, CA 90027-5209
Active Member

Canady, Alexa Irene, MD
Children's Hosp. of Michigan
3901 Beaubien, 2nd Fl.
Detroit, MI 48201-2119
Active Member

Carey, Carolyn Marie, MD
Primary Children's Med. Ctr.
100 N. Medical Dr.
Salt Lake City, UT 84113-1100
Active Member

Carmel, Peter W., MD
New Jersey Med. Sch./Neuro.
90 Bergen St., Suite #7300
Newark, NJ 07103-2499
Active Member

Carson, Benjamin, MD
Johns Hopkins Hosp.
600 N. Wolfe St./Harvey 811
Baltimore, MD 21287-8811
Active Member

Chaparro, Michael J., MD
5070 Rolling Woods Tr.
Kettering, OH 45429-1109
Active Member

Chapman, Paul H., MD
Massachusetts Gen. Hosp.
Fruit St., GR8502
Boston, MA 02114
Active Member

Cheek, William R., MD
3009 Robinhood
Houston, TX 77005-2343
Lifetime Member

Choux, Maurice, MD
Hopital Des Enfants
De La Timone, Cedex 5
Marseilles, 13385
France
International Member

Cogen, Phillip Harry, MD PhD
Children's National Med. Ctr.
111 Michigan Ave., N.W./Neuro.
Washington, DC 20010-2916
Active Member

Cohen, Alan R., MD
Case Western Reserve Univ.
11100 Euclid Ave./Neuro.
Cleveland, OH 44106-1736
Active Member

Constantini, Shlomi, MD
Dana Childrens Hosp.
6 Weizman St./Ped. Neurosurg.
Tel Aviv, 64239
Israel
International Member

Coulon, Richard A., Jr. MD
Ochsner Clinic/Neuro.
1514 Jefferson Hwy.
New Orleans, LA 70121-2429
Active Member

Cozzens, Jeffrey W., MD
Div. of Neurosurgery
2650 Ridge Ave.
Evanston, IL 60201-1718
Active Member

Crone, Kerry R., MD
Children's Hosp. Med. Ctr.
3333 Burnet Ave.
Cincinnati, OH 45229-3039
Active Member

Dagi, T. Forcht, MD
210 Morgan Farm Dr.
Atlanta, GA 30342
Active Member

Davidson, Robin I., MD
Univ. Massachusetts Med. Ctr.
55 Lake Ave., N./Neuro.
Worcester, MA 01655-0002
Active Member

Di Rocco, Concezio, MD
Univ. Cattolica/Neurochirurgia
Largo Gemelli 8
Rome, 00168
Italy
International Member

Dias, Mark S., MD
Children's Hosp. of Buffalo
219 Bryant St.
Buffalo, NY 14222-2006
Active Member

Dorsen, Michael, MD
901 S. Mo Pac Expy., #5-210
Austin, TX 78746-5776
Active Member

Doty, James R., MD
11190 Warner Ave.
Suite #404
Fountain Valley, CA 92708-4018
Active Member

Drake, James M., MD
Hosp. for Sick Children
555 University Ave., #1504-D
Toronto, ON M5G 1X8
Canada
Active Member

Duhaime, Ann-Christine, MD
Child. Hosp. of Philadelphia
34th & Civic Ctr. Blvd./Neuro.
Philadelphia, PA 19104
Active Member

Duncan, Charles Cecil, MD
333 Cedar St., TMP 416
P.O. Box 208082
New Haven, CT 06520-8082
Active Member

Duncan, John A., III MD
2 Dudley St.
Suite #530
Providence, RI 02905-3236
Active Member

Dunn, Mary E., MD
280 N. Smith Ave., #234
St. Paul, MN 55102-2420
Active Member

Edwards, Michael S. B., MD
2800 L St., #340
Sacramento, CA 95816-5616
Active Member

Egnor, Michael R., MD
NY Spine & Brain Surgery PC
Dept. of Neurosurgery/HSC T12
Stony Brook, NY 11794-8122
Active Member

Einhaus, Stephanie L., MD
Semmes-Murphy Clinic
930 Madison Ave., Suite #600
Memphis, TN 38103-2152
Active Member

Eisenberg, Howard M., MD
Div. of Neurosurgery
22 S. Greene St., #S10B11
Baltimore, MD 21201-1734
Active Member

EI Nihum, Ibrahim Muftah, MD
Scott & White Hosp.
2401 S. 31st St.
Temple, TX 76508-0001
Active Member

Ellenbogen, Richard G., MD
Children's Hosp. & Med. Ctr.
4800 Sand Point Way, N.E.
Seattle, WA 98105-0371
Active Member

Emadian, Seyed M., MD
Mountain Neuro. Inst.
7 McDowell St.
Asheville, NC 28801
Active Member

Epstein, Fred J., MD
Beth Israel Med. Ctr., N. Div.
170 E. End Ave.
New York, NY 10128-7603
Active Member

Erasmus, Mark D., MD
522 Lomas Blvd., N.E.
Albuquerque, NM 87102-2454
Active Member

Faillace, Walter J., MD
Univ. of Florida, Jacksonville
653 W. Eighth St./Neurosurgery
Jacksonville, FL 32209
Active Member

Feldstein, Neil Arthur, MD
Neurological Inst.
710 W. 168th St., Room #414
New York, NY 10032
Active Member

Fell, David A., MD
Neurosurgery Spec.
6767-A S. Yale
Tulsa, OK 74136-3303
Active Member

Fischer, Edwin G., MD
110 Francis St.
Suite #3B
Boston, MA 02215-5501
Active Member

Flannery, Ann Marie, MD
Med. Coll. of Georgia
1120 15th St./Neurosurgery
Augusta, GA 30912-4010
Active Member

Foltz, Eldon L., MD
UCI Med. Ctr./Neurosurgery
P.O. Box 14091
Orange, CA 92651
Active Member

Francel, Paul C., MD PhD
Univ. of Oklahoma HSC/Neuros.
711 Stanton L. Young Blvd., 206
Oklahoma City, OK 73104
Active Member

French, Kathleen B., MD
3020 Hamaker Ct.
Suite B104
Fairfax, VA 22031-2220
Active Member

Fried, Arno H., MD
Hackensack Univ. Med. Ctr.
30 Prospect Ave./WFAN Peds Ctr.
Hackensack, NJ 07601
Active Member

Frim, David M., MD
Univ. of Chicago MC/Neuro.
5841 S. Maryland Ave., MC-4066
Chicago, IL 60637-1463
Active Member

Fuchs, Herbert E., MD PhD
Duke Med. Ctr.
Box 3272/Neurosurgery
Durham, NC 27710-0001
Active Member

Gahn, Norman H., MD
100 Retreat Ave.
Suite #705
Hartford, CT 06106-2528
Active Member

Galich, Joseph H., MD
P.O. Box 276
Alpine, NJ 07620-0276
Lifetime Member

Gamache, Francis W., Jr. MD
Neuroscience Inst.
523 E. 72nd St., 7th Fl.
New York, NY 10021-4099
Active Member

Gaskill, Sarah J., MD
4499 Medical Dr.
Suite #397
San Antonio, TX 78229-3735
Active Member

Gennuso, Rosemaria, MD
727 Snyder Ave.
Aromas, CA 95004
Active Member

George, Richard E., Jr. MD
3506 21st St., #400
Lubbock, TX 79410-1200
Active Member

George, Timothy M., MD
Duke Univ. Med. Ctr.
Box 3272/Div. of Neurosurgery
Durham, NC 27710-0001
Active Member

Gleason, P. Langham, MD
Guthrie Square
Neurosurgery Div.
Sayre, PA 18840
Active Member

Godersky, John C., MD
2841 De Barr Rd.
Suite #34
Anchorage, AK 99508-2956
Active Member

Goodrich, James T., MD PhD
Dept. of Neuro./Montefiore
111 E. 210th St.
Bronx, NY 10467-2401
Active Member

Goumnerova, Liliana C., MD
Children's Hosp., Bader 3
300 Longwood Ave.
Boston, MA 02115-5724
Active Member

Grab, Paul A., MD
Children's Hosp.
1600 7th Ave., S., ACC 400
Birmingham, AL 35233-1711
Active Member

Greene, Clarence S., Jr. MD
2650 Elm Ave., #218
Long Beach, CA 90802
Active Member

Guido, Laurance J., MD
30 Sutton Pl., #15A
New York, NY 10022-2365
Active Member

Gutierrez, Francisco A., MD
707 N. Fairbanks Ct.
Suite #911
Chicago, IL 60611-4807
Active Member

Haase, Jens, MD
Aalborg Univ. Hosp.
Neurosurgery
Aalborg, 9100
Denmark
Active Member

Hahn, Joseph F., MD
Cleveland Clinic
9500 Euclid Ave., S80
Cleveland, OH 44195-1004
Active Member

Hahn, Yoon Sun, MD
Hope Children's Hosp.
4440 W. 95th St./Ped. Neuros.
Oak Lawn, IL 60453-2600
Active Member

Haines, Stephen J., MD
MUSC/Dept. of Neurosurgery
171 Ashley Ave.
Charleston, SC 29425-2272
Active Member

Hakanson, Sten E., MD
Karolinska Sjukhuset
Dept. of Neurosurgery
Stockholm, S-10401
Sweden
International Member

Hamilton, Mark G., MD
Alberta Children's Hosp.
1820 Richmond Rd., S.W.
Calgary, AB T2T 5C7
Canada
Active Member

Hammargren, Lonnie L., MD
3196 S. Maryland Pkwy.
Las Vegas, NV 89109-2305
Active Member

Hammock, Mary Kathryn, MD
8620 Rolling Rd.
Manassas, VA 20110-3828
Active Member

Handler, Michael H., MD
1010 E. 19th St.
Suite #605, Tammen Hall
Denver, CO 80218-1808
Active Member

Hanigan, William C., MD PhD
214 N.E. Glen Oak Ave.
Suite #500
Peoria, IL 61603
Active Member

Heafner, Michael D., MD
Carolina Neurosurgery & Spine
1010 Edgehill Rd., N.
Charlotte, NC 28207-1885
Active Member

Healy, Michael A., MD
2727 Westchester
Toledo, OH 43615-2243
Active Member

Heffez, Dan S., MD
2515 N. Clark St.
Suite #800
Chicago, IL 60614-2720
Active Member

Hellbusch, Leslie C., MD
111 N. 84th St.
Omaha, NE 68114-4101
Active Member

Hemmy, David C., MD
20611 Watertown Rd.
Suite J
Waukesha, WI 53186-1871
Active Member

Hendee, Robert W., Jr. MD
4710 Lookout Mountain Cv.
Austin, TX 78731-3654
Active Member

Hendrick, E. Bruce, MD
63 Leggett Ave.
Etobicoke, ON M9P 1X3
Canada
Lifetime Member

Hoffman, Harold J., MD
110 Bloor St., W.
Apt. #607
Toronto, ON M5S 2W7
Canada
Active Member

Holbrook, Thomas J., Jr. MD
3 Medical Park Rd.
Suite #310
Columbia, SC 29203-6873
Active Member

Hollenberg, Robert D., MD
McMaster Univ./Surgery Dept.
1200 Main St., W., Room #4E8
Hamilton, ON L8N 3Z5
Canada
Active Member

Hudgins, Roger, MD
5455 Meridan Mark Rd.
Suite #540
Atlanta, GA 30342
Active Member

Huhn, Stephen L., MD
Stanford Univ.
300 Pasteur Dr., R161
Palo Alto, CA 94305-5327
Active Member

Humphreys, Robin P., MD
Hosp. for Sick Children
555 University Ave., #1504
Toronto, ON M5G 1X8
Canada
Active Member

James, Hector E., MD
7930 Frost St.
Suite #304
San Diego, CA 92123-2737
Active Member

Jane, John A., MD PhD
Univ. of Virginia/Neurosurgery
Hosp. Box 212
Charlottesville, VA 22908
Active Member

Jimenez, David F., MD
Univ. of Missouri Hosp. & Clin
One Hospital Dr., N521
Columbia, MO 65212-0001
Active Member

Johnson, Dennis L., MD
Milton Hershey Med. Ctr.
P.O. Box 850/Div. of Neuro.
Hershey, PA 17033-0850
Active Member

Johnson, John K., MD
Greenville Neuro. Group
27 Memorial Medical Dr.
Greenville, SC 29605-4407
Active Member

Johnson, Martin, MD
501 N. Graham St.
Suite #350
Portland, OR 97227-2001
Active Member

Johnson, Mary M., MD
3223 Chatham Rd.
Atlanta, GA 30305-1101
Lifetime Member

Jones, Robert F. C., MD
21 Norfolk St.
Paddington, NSW 2021
Australia
International Member

Joseph, Allen S., MD
7777 Hennessy Blvd.
Suite #10000
Baton Rouge, LA 70808-4300
Active Member

Kalsbeck, John E., MD
Riley Children's Hosp.
702 Barnhill Dr.
Indianapolis, IN 46202-5200
Active Member

Kanev, Paul M., MD
Hershey Med. Ctr./Neurosurgery
P.O. Box 850
Hershey, PA 17033-0850
Active Member

Kasoff, Samuel S., MD
3141 Rte. 9W
New Windsor, NY 12553
Active Member

Kaufman, Bruce A., MD
St. Louis Children's Hosp.
1 Children's Pl./Neuro.
St. Louis, MO 63110
Active Member

Keating, Robert F., MD
Children's National Med. Ctr.
111 Michigan Ave., N.W./Neuro.
Washington, DC 20010-2401
Active Member

Kelly, David L., Jr. MD
Wake Forest Sch. of Med.
Medical Center Blvd./Neuro.
Winston-Salem, NC 27157-1029
Active Member

Kestle, John R. W., MD
100 N. Medical Dr.
Suite #2400/Ped. Neurosurgery
Salt Lake City, UT 84113-1100
Active Member

Klein, David M., MD
690 Fearington Post
Pittsboro, NC 27312-8507
Active Member

Kleiner, Laurence I., MD
5304 Indian Grave Rd.
Suite A
Roanoke, VA 24014-6608
Active Member

Knierim, David S., MD
Loma Linda Univ. Childrens Hosp.
11234 Anderson St., Room #6408
Loma Linda, CA 92354-2804
Active Member

Kosnik, Edward J., MD
Chatham Village Prof. Bldg.
931 Chatham Ln.
Columbus, OH 43221-2417
Active Member

Kril, Mervin P., MD
158 Oakdale St.
Redwood City, CA 94062-1737
Active Member

Laurent, John P., MD
Clinical Care Ctr., MC 3-3435
6621 Fannin, Suite #950
Houston, TX 77030-2303
Active Member

Laws, Edward R., Jr. MD
Univ. of Virginia/Neuro.
Health Sciences Ctr., Box 212
Charlottesville, VA 22908-0001
Active Member

Levy, Michael Lee, MD
1300 N. Vermont St.
Suite #906
Los Angeles, CA 90027
Active Member

Li, Veetai, MD
219 Bryant St.
Dept. of Neurosurgery
Buffalo, NY 14222-2006
Active Member

Lipow, Kenneth I., MD
267 Grant St.
Bridgeport, CT 06610-2805
Active Member

Loeser, John D., MD
Univ. of Washington
Box 356470/Neurosurgery
Seattle, WA 98195
Active Member

Loffman, Morris D., MD
16311 Ventura Blvd.
Suite #1205
Encino, CA 91436-2152
Lifetime Member

Longo-Cordero, Rafael, MD
Calle Rochester 911
Univ. Gardens
San Juan, PR 00927-4812
Active Member

Loomis, Ralph C., MD
7 McDowell St.
Asheville, NC 28801-4103
Active Member

Louis, Kenneth M., MD
3000 E. Fletcher Ave.
Suite #340
Tampa, FL 33613-4645
Active Member

Luciano, Mark G., MD PhD
Cleveland Clinic Foundation
9500 Euclid Ave., S-80
Cleveland, OH 44195-1004
Active Member

Luerssen, Thomas G., MD
Riley Hosp. for Children
One Children's Sq., #2510
Indianapolis, IN 46202-5200
Active Member

Madsen, Joseph R., MD
Children's Hosp./Neurosurgery
300 Longwood Ave., Room #312
Boston, MA 02115-5724
Active Member

Magid, Gail A., MD
1661 Soquel Dr., F
Santa Cruz, CA 95065-1709
Active Member

Magram, Gary, MD
St. Christopher's Hosp.
Erie Ave. at Front St.
Philadelphia, PA 19134
Active Member

Manwaring, Kim Herbert, MD
Phoenix Children's Hosp.
909 E. Brill St./Neurosurgery
Phoenix, AZ 85006-2513
Active Member

Mapstone, Timothy B., MD
Div. of Neurosurgery
University Station
Birmingham, AL 35294
Active Member

Marlin, Arthur E., MD
Methodist Plaza
4499 Medical Dr., Suite #397
San Antonio, TX 78229-3713
Active Member

Mawk, John R., MD
1601 N.W. 114th St.
Suite #134
Des Moines, IA 50325-7007
Active Member

McAllister, James P., II PhD
Wayne State Univ./Neurosurgery
4201 St. Antoine, #6E
Detroit, MI 48201
Associate Member

McCallum, Jack E., MD
800 8th Ave.
Suite #220
Fort Worth, TX 76104-2619
Active Member

McComb, J. Gordon, MD
1300 N. Vermont Ave.
Suite #906
Los Angeles, CA 90027-6005
Active Member

McLanahan, C. Scott, MD
Carolina Neuros. & Spine Assoc.
1010 Edgehill Rd., N.
Charlotte, NC 28207-1885
Active Member

McLaurin, Robert L., MD
2412 Ingleside Ave.
Apt. #5C
Cincinnati, OH 45206-2185
Lifetime Member

McLone, David Gordon, MD PhD
Children's Mem. Hosp.
2300 Children's Plaza, Box 28
Chicago, IL 60614-3318
Active Member

Meacham, William F., MD
Neuro. Assoc./4230 Harding Rd.
709 Medical Plaza, E.
Nashville, TN 37205
Lifetime Member

Mealey, John, Jr. MD
Indiana Univ. Med. Ctr.
545 Barnhill, Emerson #139
Indianapolis, IN 46202-5112
Lifetime Member

Menezes, Arnold H., MD
Univ. of Iowa Hosp. & Clinics
200 Hawkins Dr.
Iowa City, IA 52242-1009
Active Member

Meyer, Glenn A., MD
Med. Coll. of Wisconsin
9200 W. Wisconsin Ave.
Milwaukee, WI 53226-3522
Active Member

Michelsen, W. Jost, MD
Harbour Place, #15
135 Bow St.
Portsmouth, NH 03801
Active Member

Milhorat, Thomas H., MD
State Univ. of NY/HSC-Brooklyn
Box 1189, 450 Clarkson Ave.
Brooklyn, NY 11203-2098
Active Member

Miller, Clinton F., MD
Coastal New Hampshire Neuro.
330 Borthwick Ave., Suite #108
Portsmouth, NH 03801-7110
Active Member

Miller, John I., MD
St. John's Queens Hosp./Neuro.
95-25 Queens Blvd., 2nd Fl.
Rego Park, NY 11374
Active Member

Moel, Richard H., MD
3656 Ella Lee Ln.
Houston, TX 77027-4105
Lifetime Member

Monasky, Mark S., MD
900 E. Broadway
P.O. Box 1114
Bismarck, ND 58502-1114
Active Member

Montes, Jose L., MD
The Montreal Children's Hosp.
2300 Tupper St., Room C811
Montreal, PQ H3H 1P3
Canada
Active Member

Montoya, German, MD
1801 Cook Ave.
Orlando, FL 32806-2913
Active Member

Moradi, Mahmood, MD
920 Frostwood
Suite #640
Houston, TX 77024
Active Member

Morris, William J., MD
1112 6th Ave., #302
Tacoma, WA 98405-4048
Active Member

Morrison, Glenn, MD
Miami Children's Hosp.
3200 S.W. 60 Ct., Suite #301
Miami, FL 33155-4071
Active Member

Moss, S. David, MD
Phoenix Children's Hosp.
909 E. Brill St.
Phoenix, AZ 85006-2513
Active Member

Muakkassa, Kamel F., MD
130 W. Exchange St.
Akron, OH 44302-1701
Active Member

Muhlbauer, Michael S., MD
930 Madison Ave.
Suite #600
Memphis, TN 38103-3401
Active Member

Muhonen, Michael G., MD
455 S. Main
Orange, CA 92868
Active Member

Myles, S. Terence, MD
1820 Richmond Rd., S.W.
Calgary, AB T2T 5C7
Canada
Active Member

Nadell, Joseph M., MD
Children's Hosp.
200 Henry Clay Ave.
New Orleans, LA 70118-5720
Active Member

Nagib, Mahmoud G., MD
305 Piper Bldg.
800 E. 28th St.
Minneapolis, MN 55407-3799
Active Member

Nagle, Richard C., MD
3000 Colby
Suite #101
Berkeley, CA 94705-2058
Active Member

Nazar, Gregory, MD
5008 Long Knife Run
Louisville, KY 40207-1175
Active Member

Nirmel, Krishna, MD
10 Union St.
Natick, MA 01760-4710
Active Member

O'Brien, Mark Stephen, MD
1900 Century Blvd.
Suite #4
Atlanta, GA 30345-3307
Active Member

Oakes, W. Jerry, MD
Children's Hosp. of Alabama
1600 7th Ave., S., Suite #400
Birmingham, AL 35233
Active Member

Page, Larry Keith, MD
13845 S.W. 73rd Ct.
Miami, FL 33158-1213
Lifetime Member

Pang, Dachling, MD
Univ. of California, Davis
4860 Y St., #3740
Sacramento, CA 95817
Active Member

Parent, Andrew D., MD
Univ. of Mississippi MC
2500 N. State St.
Jackson, MS 39216
Active Member

Park, Tae Sung, MD
St. Louis Children's Hosp.
1 Children's Pl./Neurosurgery
St. Louis, MO 63110
Active Member

Partington, Michael David, MD
Neurosurgery Assoc.
280 N. Smith Ave., #234
St. Paul, MN 55102
Active Member

Pattisapu, Jogi V., MD
22 W. Lake Beauty Dr.
Suite #204
Orlando, FL 32806-2037
Active Member

Penix, Jerry O., MD
607 Medical Tower
Norfolk, VA 23507
Active Member

Piatt, Joseph H., Jr. MD
3181 S.W. Sam Jackson Park Rd.
Div. of Neurosurgery (L-472)
Portland, OR 97201-3098
Active Member

Pittman, Hal Watson, MD
44 E. Palm Ln.
Phoenix, AZ 85004
Active Member

Pittman, Thomas, MD
St. Louis Univ. Hosp.
1465 S. Grand
St. Louis, MO 63110-1003
Active Member

Pollack, Ian F., MD
Children's Hosp. of Pittsburgh
3705 Fifth Ave./Neurosurgery
Pittsburgh, PA 15213-2524
Active Member

Portnoy, Harold D., MD
1431 Woodward Ave.
Bloomfield Hills, MI 48302-0550
Active Member

Prats, Antonio R., MD
P.O. Box 440757
Miami, FL 33144-0757
Active Member

Raffel, Corey, MD PhD
Mayo Clinic/Neurosurgery
200 First St., S.W.
Rochester, MN 55905-0001
Active Member

Raimondi, Anthony J., MD
Villa Monteleone
37020 Gargagnago
Verona, 37100
Italy
Active Member

Reigel, Donald H., MD
134 Shenot Rd.
Wexford, PA 15090
Lifetime Member

Rekate, Harold Louis, MD
Barrow Neurosurg. Assoc. Ltd.
2910 N. 3rd Ave.
Phoenix, AZ 85013-4434
Active Member

Reynolds, Arden F., Jr. MD
Magan Med. Clinic
420 W. Rowland Ave.
West Covina, CA 91723-2943
Active Member

Roberts, Theodore S., MD
Univ. of Washington/Neuro.
CH-50, P.O. Box 5371
Seattle, WA 98195
Active Member

Robinson, Walker L., MD
New Jersey Neurosci. Inst.
65 James St./Neurosurgery
Edison, NJ 08818
Active Member

Rodriguez, Luis A., MD
1150 N. 35th Ave.
Suite #300
Hollywood, FL 33021-5424
Active Member

Rosenblum, Bruce R., MD
Riverview Med. Ctr.
160 Ave. at The Commons
Shrewsbury, NJ 07702
Active Member

Rosenthal, Alan, MD
Long Island Neuro. Assoc.
410 Lakeville Rd.
New Hyde Park, NY 11042-1101
Active Member

Rothman, Allen S., MD
1160 Fifth Ave.
Suite #106
New York, NY 10029-6928
Active Member

Ruge, John R., MD
630 S. Oak St.
Hinsdale, IL 60521-4634
Active Member

Rutka, James T., MD
Hosp. for Sick Children
555 University Ave./Neuro.
Toronto, ON M5G 1X8
Canada
Active Member

Ruzicka, Petr O., MD
741 Northfield Ave.
West Orange, NJ 07052-1104
Active Member

Sanford, Robert A., MD
Semmes-Murphey Clinic
930 Madison Ave., Suite #600
Memphis, TN 38103-3401
Active Member

Sato, Osamu, MD
1-5-40, Tamagawa Gakuen
Machida
Tokyo, 194-0041
Japan
International Member

Scarf, Timothy B., MD
33 S.W. Upper Riverdale Rd.
Suite #25
Riverdale, GA 30274-2626
Active Member

Schiff, Steven J., MD
George Mason Univ.
Krasnow Inst., MS-2A1
Fairfax, VA 22030
Active Member

Schneider, Steven J., MD
Long Island Neuro. Assoc.
410 Lakeville Rd.
New Hyde Park, NY 11042-1101
Active Member

Schut, Luis, MD
Children's Hosp. Philadelphia
34th and Civic Ctr. Blvd.
Philadelphia, PA 19104
Lifetime Member

Scott, R. Michael, MD
The Children's Hosp.
300 Longwood Ave., Bader 319
Boston, MA 02115-5724
Active Member

Seljeskog, Edward L., MD
2805 Fifth St., S.
Suite #110
Rapid City, SD 57701-7306
Active Member

Selker, Robert G., MD
Western Pennsylvania Hosp.
4800 Friendship Ave./Neuro.
Pittsburgh, PA 15224-1722
Active Member

Shallat, Ronald F., MD
3000 Colby St.
Suite #101
Berkeley, CA 94705-2058
Active Member

Shapiro, Kenneth N., MD
1935 Motor St.
Dallas, TX 75235-7794
Active Member

Shillito, John, MD
1109 Fearrington Post
6 Caswell Square
Pittsboro, NC 27312-5014
Active Member

Simmons, James C., MD
190 Grove Park Rd.
Memphis, TN 38117
Lifetime Member

Simonds, Gary Robert, MD
237 Sunbury Rd.
P.O. Box 14
Riverside, PA 17868-0014
Active Member

Sklar, Frederick H., MD
1935 Motor St.
Dallas, TX 75235-7794
Active Member

Smith, Harold P., MD
300 20th Ave., N., #506
Nashville, TN 37203-2131
Active Member

Smith, Lenwood P., Jr. MD
3 Medical Park
Suite #310
Columbia, SC 29203
Active Member

Souweidane, Mark M., MD
New York Hosp./Star Pav.
520 E. 70th St., Room #651
New York, NY 10021
Active Member

St. Louis, Phillip G., MD
2501 N. Orange Ave.
Suite #500 N.
Orlando, FL 32804
Active Member

Stein, Sherman Charles, MD
310 Spruce St.
Philadelphia, PA 19106-4201
Active Member

Steinbok, Paul, MD
B.C. Children's Hosp.
4480 Oak St., Room A325
Vancouver, BC V6H 3V4
Canada
Active Member

Storrs, Bruce B., MD
2211 Lomas Blvd., N.E.
Dept. of Neurosurgery/ACC2
Albuquerque, NM 87131-5341
Active Member

Stringer, Douglas L., MD
2011 Harrison Ave.
Panama City, FL 32405-4545
Active Member

Stringer, Merle Preston, MD
2011 N. Harrison Ave.
Panama City, FL 32405-4545
Active Member

Sukoff, Michael H., MD
17602 17th St., #102-118
Tustin, CA 92680-1961
Lifetime Member

Susen, Anthony F., MD
Anthony F. Susen
193 Old Glebe Point Rd
Burgess, VA 22432
Lifetime Member

Sutton, Leslie N., MD
Child. Hosp. of Philadelphia
34th & Civic Center Blvd.
Philadelphia, PA 19104
Active Member

Taekman, Michael S., MD
15 Oakmont Ct.
San Rafael, CA 94901-2058
Active Member

Tew, John M., Jr. MD
Mayfield Clinic
506 Oak St.
Cincinnati, OH 45219
Active Member

Tomita, Tadanori, MD
Children's Mem. Hosp./Neuros.
2300 Children's Plaza, Box 28
Chicago, IL 60614-3318
Active Member

Tulipan, Noel, MD
8533 McCrory Ln.
Nashville, TN 37221-5905
Active Member

Turner, Michael S., MD
1801 N. Senate Blvd.
Suite #535
Indianapolis, IN 46202-1228
Active Member

Udehn, David D., MD
4350 Seventh St.
Moline, IL 61265-6870
Active Member

Uscinski, Ronald H., MD
3301 Woodburn Rd., #209
Annandale, VA 22003-1229
Active Member

Venes, Joan L., MD
27517 Via Montoya
San Juan Capistrano, CA 92675-5364
Active Member

Ventureyra, Enrique C., MD
401 Smyth Rd.
Ottawa, ON K1H 8L1
Canada
Active Member

Vries, John Kenric, MD
Univ. of Pittsburgh
217 Victoria Bldg.
Pittsburgh, PA 15261-0001
Active Member

Wald, Steven L., MD
10 Grove Ln.
Shelburne, VT 05482-7232
Active Member

Waldman, John B., MD
Albany Med. Coll.
Div. of Neurosurgery/MC-61-NE
Albany, NY 12208
Active Member

Walker, Marion L., MD
Primary Children's Med. Ctr.
100 N. Medical Dr.
Salt Lake City, UT 84113-1100
Active Member

Walsh, John Willson, MD
Tulane Univ. MC/Neurosurgery
1430 Tulane Ave., SL-47
New Orleans, LA 70122
Active Member

Ward, John D., MD
Virginia Commonwealth Univ.
Box 980631
Richmond, VA 23298-0631
Active Member

Warf, Benjamin C., MD
Univ. of Kentucky Med. Ctr.
800 Rose St./Neurosurgery
Lexington, KY 40536-0084
Active Member

Weiss, Martin H., MD
LAC/USC Med. Ctr., Box 786
1200 N. State St., Room #5046
Los Angeles, CA 90033
Active Member

White, Robert Joseph, MD PhD
MetroHealth Med. Ctr.
2500 MetroHealth Dr.
Cleveland, OH 44109-1998
Active Member

Wickersham, Jean K., MD
3030 Children's Way
Suite #402
San Diego, CA 92123
Lifetime Member

Willman, Philip J. A., MD
3006 S. Alameda St.
Corpus Christi, TX 78404-2601
Active Member

Wilson, Ronald J., MD
1313 Red River
Suite #120
Austin, TX 78701-1923
Active Member

Winer, Joel W., MD
York Neurosurgical Assoc., PC
2319 S. George St.
York, PA 17403-5009
Active Member

Winfield, Jeffrey A., MD PhD
Hill Med. Ctr.
1000 E. Genesee St., Ste. #202
Syracuse, NY 13210-1853
Active Member

Winston, Ken R., MD
1950 Ogden, B467
Denver, CO 80218-1022
Active Member

Wisoff, Jeffrey H., MD
NYU Med. Ctr./Ped. Neurosurg.
550 1st Ave.
New York, NY 10016
Active Member

Woodward, Meredith V., MD
4208 W. Alluvial
Fresno, CA 93722
Active Member

Yamada, Shokei, MD
Loma Linda Univ. Sch. of Med.
Room #2562B/Neurosurgery
Loma Linda, CA 92350-0001
Active Member

Zakalik, Karol, MD
Wm. Beaumont Hosp.
3535 W. 13 Mile Rd., Suite #504
Royal Oak, MI 48073-6704
Active Member

Zampella, Edward J., MD
10 Parrott Mill Rd.
P.O. Box 808
Chatham, NJ 07928-2744
Active Member

Zanetti, Paul Henry, MD
5920 Saratoga Blvd.
Suite #440
Corpus Christi, TX 78414-4108
Active Member

Zavala, L. Manuel, MD
2400 Country Dr., #100
Fremont, CA 94536
Active Member

Zovickian, John G., MD
3000 Colby St.
Suite #101
Berkeley, CA 94705-2058
Active Member

Notes

