AANS/CNS Section on Pediatric Neurological Surgery
5550 Meadowbrook Drive
Rolling Meadows, IL 60008-3852
Telephone (847) 378-0500
Facsimile (847) 378-0600
www.neurosurgery.org/pediatric

# SAVE THE DATE FOR 2005

2005 Annual Meeting of the
AANS/CNS Section on
Pediatric Neurological Surgery

December 6–9, 2005

Grand Hotel Marriott Resort,
Golf Club & Spa

Point Clear, Alabama

American Association of Neurological Surgeons

# 004 PROGRAM BOOK

e 33rd Annual Meeting of the AANS/CNS Section on **PEDIATRIC** Neurological Surgery

December 8–11, 2004
Hyatt Regency San Francisco
Embarcadero Center

The program book was made possible, in part, by an educational grant provided by

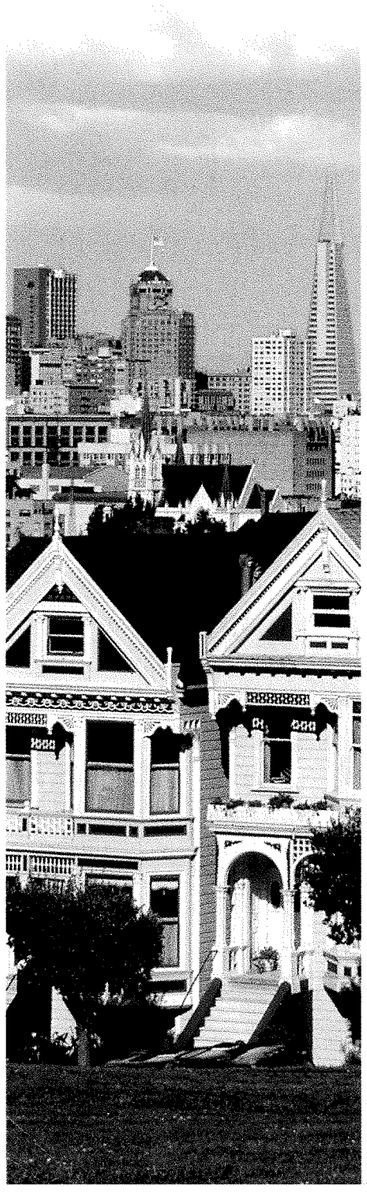
Codman
a Johnson & Johnson company

American Association of Neurological Surgeons

# 33RD ANNUAL MEETING

AANS/CNS SECTION
ON PEDIATRIC
NEUROLOGICAL SURGERY

December 8-11, 2004
San Francisco, CA



## CONTINUING MEDICAL EDUCATION CREDIT (CME)

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 Accreditation Council accredits the American Association of Neurological Surgeons for Continuing Medical Education to sponsor continuing medical education for physicians.

The AANS designates this educational activity for a maximum of 18 hours in Category 1 credit toward the AMA Physician's Recognition Award, with an additional 3.5 hours for the pre-meeting coding course or 5.5 hours for the pre-meeting spinal instrumentation course. Each physician should claim only those hours that he or she actually spends in the educational activity.

## DISCLAIMER

All drugs and medical devices used in the United States are administered in accordance with Food and Drug Administration (FDA) regulations. These regulations vary depending on the risks associated with the drug or medical devices compared to products already on the market, and the quality and scope of the clinical data available.

Some drugs and medical devices demonstrated or described on the print publications of the AANS/CNS Section on Pediatric Neurological Surgery have a FDA clearance for use for specific purposes or for use only in restricted research settings. The FDA has stated that it is the responsibility of the physician to determine the FDA status of each drug or device he or she wishes to use in compliance with applicable law.

American Association of Neurological Surgeons

Jointly Sponsored by the American Association of Neurological Surgeons

# TABLE OF CONTENTS

## ANNUAL MEETING SITES

1972 Cincinnati
1973 Columbus
1974 Los Angeles
1975 Philadelphia
1976 Toronto
1977 Cleveland
1978 Philadelphia
1979 New York
1980 New York
1981 Dallas
1982 San Francisco
1983 Toronto
1984 Salt Lake City
1985 Houston
1986 Pittsburgh
1987 Chicago
1988 Scottsdale
1989 District of Columbia
1990 San Diego/Pebble Beach
1991 Boston
1992 Vancouver, BC
1993 San Antonio
1994 St. Louis
1995 Pasadena
1996 Charleston
1997 New Orleans
1998 Indianapolis
1999 Atlanta
2000 San Diego
2001 New York
2002 Scottsdale
2003 Salt Lake City
2004 San Francisco

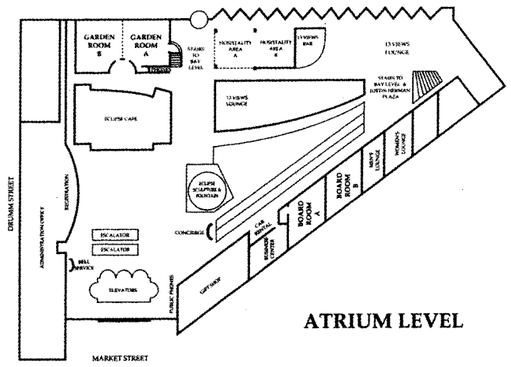
## FUTURE MEETING SITES

2005 Point Clear
2006 Denver

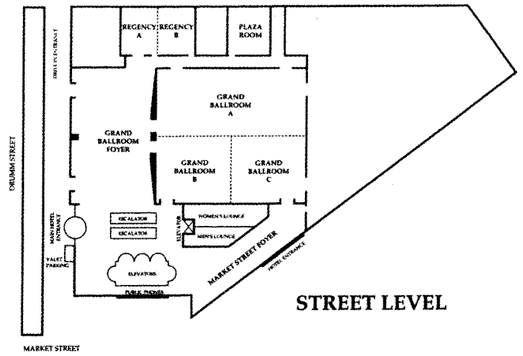


Microscope more
Endoscopy
Quick Brain MRI

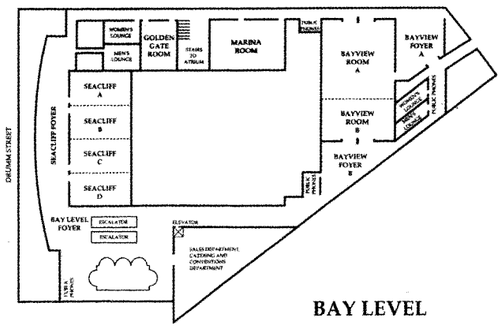
# HOTEL FLOOR PLAN



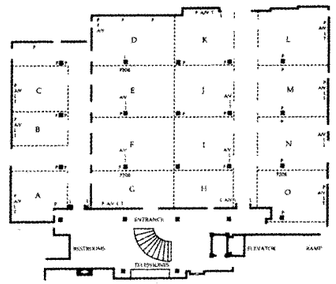

ATRIUM LEVEL




STREET LEVEL




BAY LEVEL




THE PACIFIC CONCOURSE

## EVENTS AND ROOMS AT-A-GLANCE DIRECTORY

| Event | Room | Level |
|---|---|---|
| Wednesday Taste of San Francisco Reception | Atrium 3-4, 13 Views Lounge | Atrium |
| Speaker Ready Room | Regency A | Street |
| Exhibits/Posters/Breaks/Breakfast | Pacific Concourse D-O | Pacific Concourse |
| Scientific Sessions | Grand Ballroom A | Street |
| Thursday Lifetime Achievement Reception | Garden Room | Atrium |
| Friday Wine and Cheese Reception | Pacific Concourse D-O | Pacific Concourse |



# OFFICERS AND STANDING

## PEDIATRIC SECTION CHAIRS

1972–73 Robert L. McLaurin

1973–74 M. Peter Sayers

1974–75 Frank Anderson

1975–76 Kenneth Shulman

1976–77 E. Bruce Hendrick

1977–78 Frank Nulsen

1978–79 Luis Schut

1979–81 Fred J. Epstein

1981–83 Joan L. Venes

1983–85 Harold J. Hoffman

1985–87 William R. Cheek

1987–89 David G. McLone

1989–91 Donald H. Reigel

1991–93 R. Michael Scott

1993–95 Arthur Marlin

1995–97 Harold L. Rekate

1997–99 Marion L. Walker

1999–01 John P. Laurent

2001–03 Thomas G. Luerssen

2003–05 Andrew D. Parent

# COMMITTEES

## OFFICERS

Chair .....Andrew D. Parent, MD (2003–2005)

Chair-Elect .....Rick Abbott, MD (2003–2005)

Secretary.....Jeffrey H. Wisoff, MD (2003–2005)

Treasurer.....Ann-Christine Duhaime, MD (2003-2005)

Past Chair .....Thomas G. Luerssen, MD (2003–2005)

## EXECUTIVE COMMITTEE

Members at Large (two-year term) .....Sarah J. Gaskill, MD (2004–2006)
Bruce Kaufman, MD (2003 – 2005)
Michael Partington, MD (2004-2006)
Ian Pollack, MD (2003–2005)

## STANDING COMMITTEES

Nominating Committee .....Marion L. Walker, MD (1999)
John P. Laurent, MD (2001)
Thomas G. Luerssen, MD (2003)

Rules and Regulations Committee .....Chair: Cheryl A. Muszynski, MD (2002–2004)
Nathan R.W. Selden, MD, PhD (2003–2005)
Herbert E. Fuchs, MD, PhD (2003–2005)

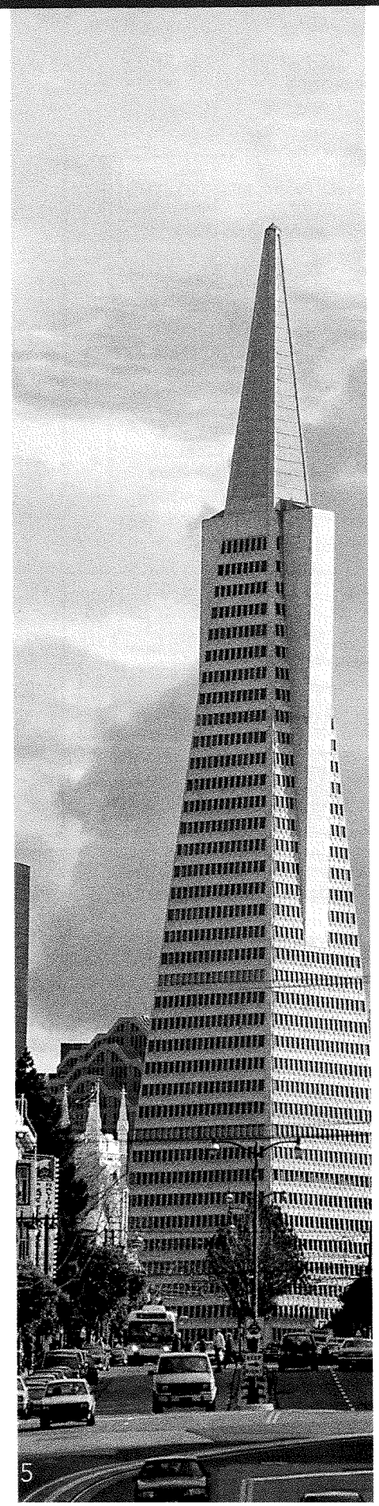
Membership Committee .....Chair: John Kestle, MD, MSc (2002–2004)
Mark D. Krieger, MD (2003–2005)
Roger Hudgins, MD (2003–2005)

Program and Continuing Education Committee .....Chair: Ann Marie Flannery, MD, FACS FA (2003–2005)
Vice Chair: Joseph R. Madsen, MD (2002–2004)
Ex Officios: Andrew D. Parent, MD
Ann-Christine Duhaime, MD

Annual Meeting.....Chair: Nalin Gupta, MD, PhD

Future Annual Meeting.....Chair: W. Jerry Oakes, MD (2005)
Michael H. Handler, MD (2006)

# AD HOC COMMITTEES

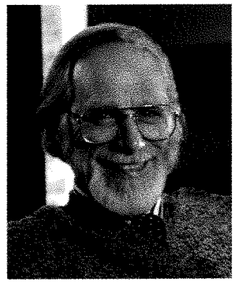


| | |
|---|---|
| Traveling Fellowship Committee | Chair: R. Michael Scott, MD |
| Lifetime Achievement Award | Chair: Thomas G. Luerssen, MD |
| NEUROSURGERY://ON-CALL® Web site | Chair: Douglas L. Brockmeyer, MD |
| Publications Committee | Chair: Sarah J. Gaskill, MD |
| Liaison to the American Academy of Pediatrics | Joseph H. Piatt, Jr., MD |
| Liaison to the Joint Council of State Neurosurgical Societies | Michael Heafner, MD |
| Representatives to AANS Executive Committee | Andrew D. Parent, MD<br>Alternate: Rick Abbott, MD |
| Representatives to CNS Executive Committee | Andrew D. Parent, MD<br>Alternate: Rick Abbott, MD |
| Representative to the Quality Assurance Committee | Paul A. Grabb, MD |
| Representative to the Washington Committee | Thomas G. Luerssen, MD |
| Representative to the Neurological Surgery Political Action Committee | Michael Medlock, MD |
| Representatives to the Outcomes Committee | Bruce A. Kaufman, MD<br>John R.W. Kestle, MD, MSc |
| Representative to ISPN | Cheryl A. Muszynski, MD<br>Alternate: Bruce Kaufman, MD |



# 2004 RAIMONDI LECTURER

## J. MICHAEL BISHOP, MD



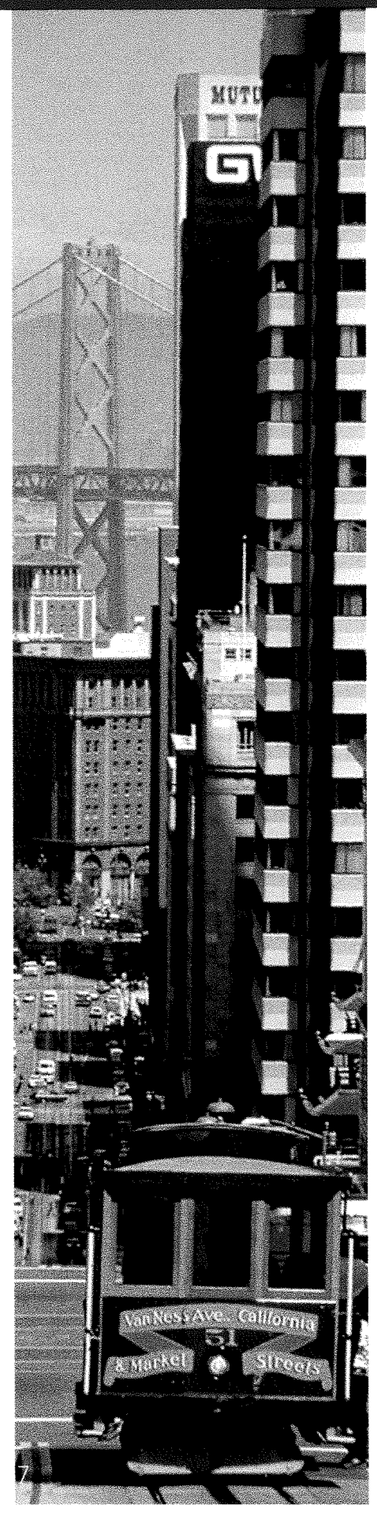
J. Michael Bishop was born and raised in rural Pennsylvania, and educated at Gettysburg College and Harvard Medical School. While a medical student, he developed an interest in the newly burgeoning field of molecular biology. After a two year hiatus for training in internal medicine, he renewed his pursuit of virus research at the National Institutes of Health in Bethesda, Maryland. In 1967, Dr. Bishop joined a German collaborator in Hamburg. The ensuing year saw little success in research. He then moved to UCSF where he is a Professor and Chancellor and has remained there ever since.

Dr. Bishop began his research career working on the replication of poliovirus. But soon after arriving in San Francisco, he shifted his attention to Rous sarcoma virus. In 1970, he was joined by Dr. Harold Varmus. Together, they directed the research that led to the discovery of proto-oncogenes. Bishop has devoted his subsequent research to the study of proto-oncogenes – their functions in normal cells and the manner in which they become cancer genes. In 1989, he and Harold Varmus received the Nobel Prize in Physiology or Medicine.

Dr. Bishop has served at The Salk Institute; the National Cancer Advisory Board; the Advisory Committee to the Director of NIH, the Medical Advisory Board for the Howard Hughes Medical Institute, and the Board of Overseers for Harvard University; the Leukemia Society of America, the American Cancer Society, the Burroughs Wellcome Foundation, the St. Jude's Hospital, the Roche Institute of Molecular Biology, the European Institute of Oncology, the DNAX Research Institute of Molecular & Cellular Biology, the Institute of Molecular Pathology in Vienna, the Basel Institute of Immunology, the San Francisco Exploratorium; and President of the American Society for Cell Biology.

Dr. Bishop is a member of the National Academy of Science, the Institute of Medicine, and the American Academy of Arts & Sciences. He has received numerous awards for his teaching and research. He has also been recognized for his efforts to improve the public understanding of science and federal support for research. He is the author of more than 300 research publications and reviews, and of the book *How to Win the Nobel Prize: An Unexpected Life in Science*, published by Harvard University Press.

# LECTURERS




## RAIMONDI LECTURERS

1978 E. Bruce Hendrick
1979 Paul C. Bucy
1980 Floyd Gilles
1981 Panel Discussion
1982 Panel Discussion
1983 Derek Harwood-Nash
1984 Anthony E. Gallo, Jr.
1985 Frank Nulsen
1986 William F. Meacham
1987 Dale Johnson
1988 Joseph J. Volpe
1989 Martin Eichelberger
1990 George R. Leopold
1991 Judah Folkman
1992 Olof Flodmark
1993 Maurice Albin
1994 Blaise F.D. Bourgeois
1995 Robert H. Pudenz
1996 Samuel S. Flint
1997 M. Michael Cohen, Jr.
1998 Robert A. Zimmerman
1999 David B. Schurtleff
2000 Steve Berman
2001 Alejandro Berenstein
2002 Volker K.H. Sonntag
2003 Jon Huntsman
2004 J. Michael Bishop

## MATSON MEMORIAL LECTURERS

1987 John Shillito
1988 E. Bruce Hendrick
1989 Martin P. Sayers
1990 Roger Guillemin
1991 Robert L. McLaurin
1992 Joseph Murray
1993 Eben Alexander, Jr.
1994 Joseph Ranschoff
1995 John Holter
1996 None
1997 Maurice Choux
1998 Lisa Shut
1999 Gary C. Schoenwolf
2000 Postponed due to illness
2001 Donald H. Reigel
2002 David McLone
2003 Robin P. Humphreys
2004 A. Leland Albright



# 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 ANN-CHRISTINE DUHAIME The Shaken Baby Syndrome

1986 ROBERT E. BREEZE 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 Hemotoma in Infant Piglets

1995 SEYED M. EMADIAN Correlation of Chromosome 17p Loss with Clinical Outcome in Patients with Primitive Neuroectodermal Tumors

1996 JOHN PARK Platelet Derived Growth Factor Induces Differentiation of Neuroepithelial Stem Cells into Neurons

1997 MICHAEL J. DREWEK Quantitative Analysis of the Toxicity of Human Amniotic Fluid to Rat Fetal Spinal Cord Cultures

1998 ADRIANA RANGER Implantation of Medulloblastoma Cells into Collagen Type I Gels: Invasiveness, Enzymatic Characterization, and the Impact of Surgical Excision and Radiation

1999 SUSAN DURHAM The Surprisingly Sturdy Infant Brain: Why is it More Resistant to Focal Injury?

2000 KETAN R. BULSARA Novel Findings in the Development of the Normal and Tethered Filum Terminale

2001 DAVID I. SANDBERG Convection Enhanced Delivery into the Rat Brain Stem: A Potential Delivery for the Treatment of Diffuse Pontine Gliomas

2002 DAVID ADAMSON Mechanisms of Reclosure in 2 Surgical Models of Myelomeningocele Implications for Fetal Surgery

2003 JOSHUA E. MEDOW Posture Independent Piston Valve: A Practical Solution to Maintaining Stable Intracranial Pressure in Shunted Hydrocephalus

2004 TO BE ANNOUNCED

# 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 NESHER 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 Prize Awarded

1998 DANIEL LIEBERMAN In Vetro Detection of Fluid Flow in Ventriculoperitoncal Shunts (VPS) Using Contrast Enhanced Ultrasound

1999 KIMBERLY BINGAMAN Hydrocephalus Induces the Proliferation of Cells in the Subventricular Zone

2000 No Prize Awarded

2001 JAKE TIMOTHY Treatment of Hydrocephalus Using a Choroid Plexus Specific Immunotoxin: An In Vitro Study

2002 JOSHUA MEDOW Quick Brain MRI vs. CT Scan for Evaluating Shunted Hydrocephalus

2002 JONATHAN MILLER Abberant Neuronal Development in Hydrocephalus

2003 MARTIN U. SCHUHMANN Serum and CSF C-Reactive Protein in Shunt Infection Management

2004 TO BE ANNOUNCED

## TRAVELING FELLOWSHIP AWARDS

### DOMESTIC

JOHN DAVID MORENSKI
PRITHVI MORENSKI

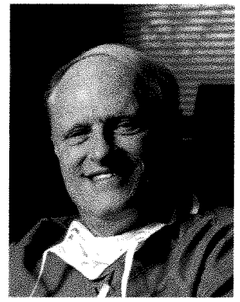
### INTERNATIONAL

CHARITY CORDERO





## FRED J. EPSTEIN, MD



Fred J. Epstein was born in Yonkers, New York. The middle son of an intellectually gifted family, his struggles with learning issues challenged both him and his parents. It may be this one factor more than any other that formed his character: his drive, his work ethic, his enthusiasm for challenges and his empathy for children.

Upon receiving his BA from New York University in 1959 and his MD from New York Medical College in 1963, Dr. Epstein performed his surgical internship and surgical residency at Montefiore Medical Center in New York City. In 1970 he completed his neurosurgical residency at New York University Medical Center while serving in the United States Army Reserve. Subsequently, Dr. Epstein was appointed to the NYU Medical Center as an Assistant Professor of Neurosurgery. In 1983, he was named professor Neurosurgery and two years later he was appointed as the first Director of the Division of Pediatric Neurosurgery.

Beginning with the publication of his 1981 paper, "Surgical Management of 'Holeovd Intramedullary Spinal Cord Astrocytomas in Children," Dr. Epstein undertook and solved many of the problems relating to the neurosurgical treatment of spinal cord tumors, which had previously been deemed insurmountable. His extensive documentation of new techniques and neurosurgical methodology helped advance the treatment of both spinal cord and brain stem tumors.

During his career, Dr. Epstein has served as President of the International Society of Pediatric Neurosurgery, the American Society of Pediatric Neurosurgery, the Pediatric Section of the American Association of Neurological Surgeons/Congress of Neurological Surgeons and Editor-in-Chief of the Journal of Pediatric Neurosurgery. He received fellowships from the American College of Surgeons, the New York Academy of Medicine and the American Academy of Pediatrics. He has published more than 175 papers and has trained pediatric neurosurgeons practicing in the United States, Canada, Europe, the Middle East and Asia.

Following a personal imperative to provide patients with both comfort and state-of-the-art technology, Dr. Epstein was intimately involved in the creation of the Institute of Neurology and Neurosurgery at Beth Israel Medical Center in New York City. It was there that he was able to fulfill his dream of a technologically advanced facility where the special needs of his young patients and their families dealing with the most serious illnesses could be treated in a truly caring and unique environment. Dr. Epstein's philosophy about caring for children is chronicled in his recent book, *If I Get to Five, What Children Can Teach Us About Courage and Character.*

# PROGRAM SCHEDULE

## WEDNESDAY, DECEMBER 8

10:00 AM - 5:00 PM
SPINAL INSTRUMENTATION COURSE
University of California San Francisco-Rosegay Library (Rm M787) and Anatomy Lab (Rm S1320)

*Faculty: Douglas L. Brockmeyer, MD; Henry M. Bartkowski, MD, PhD; Paul A. Grabb, MD; Christopher P. Ames, MD*

Learning Objectives
After completion of this course, participants should be able to:

- Demonstrate familiarity with instrumentation available for C1-2 fixation.
- Evaluate and apply the latest surgical techniques for C1-2 fixation in children.

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11:00 AM – 7:00 PM
REGISTRATION
Grand Ballroom A Foyer-Street Level

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12:00 – 5:00 PM
ADVANCED CODING STRATEGIES
Seacliff D-Bay Level
*Faculty: John G. Piper, MD*

Learning Objective
After completion of this course, participants should be able to:

- Apply knowledge of CPT coding to their practice.

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12:00 - 6:00 PM
PRE-MEETING NURSES' SEMINAR
Seacliff C-Bay Level
*Faculty: James Goodrich, MD; Erin Hanson, RN, MS, CPNP; Bernadette Caputto, RN, MSN, NP-C; Dawn Kurley-Schafer, RN, CFA; Herta Yu, RNMN-ACNP, CNNC*

Learning Objectives
After completion of this course, participants should be able to:

- Identify CNS neoplasms seen in infants and treatments for infantile neoplasms.
- Discuss the surgical planning, management, perioperative and postoperative nursing care for the patient with Kleeblattschadel.
- Describe the various vascular malformations found in children and their neurosurgical interventions.
- Describe the population of patients with baclofen pumps at the Hospital for Sick Children in Toronto, Canada.
- Describe the development of guidelines of care for holistic care of these children.
- Review the surgical approach and preparation of this surgery and describe the team approach.

6:00 - 8:00 PM
TASTE OF SAN FRANCISCO
OPENING RECEPTION
Atrium 3-4, 13 Views Lounge-Atrium Level

## THURSDAY, DECEMBER 9

7:00 – 8:00 AM
CONTINENTAL BREAKFAST IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse Level

7:00 AM – 4:00 PM
EXHIBIT & POSTER VIEWING IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse Level

7:00 AM – 5:30 PM
REGISTRATION
Grand Ballroom A Foyer-Street Level

8:00 - 8:05 AM
WELCOME AND OPENING REMARKS
*Andrew D. Parent, MD*
Grand Ballroom A-Street Level

8:05 - 8:15 AM
MEETING OVERVIEW
*Nalin Gupta, MD, PhD*
Grand Ballroom A-Street Level

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8:15 - 9:45 AM
SCIENTIFIC SESSION I
Trauma
Grand Ballroom A-Street Level
*Moderators: Ann-Christine Duhaime, MD; Mark S. Dias, MD*

Learning Objectives
Upon completion of this program, participants should be able to:

- Describe the demographics of nonaccidental trauma in children.
- Critically evaluate the validity of published guidelines for treatment of pediatric head injury.
- Identify controversies in the management of closed head injuries in pediatric patients.

8:15 - 8:25 AM
**1. Demographics of Infant Abusive Head Trauma in Pennsylvania**
*Mark S. Dias, MD; Henry Kesler; Michele L. Shaffer, PhD; Neal J. Thomas, MD (Hershey, PA)*

8:25 - 8:35 AM
**2. Skull Fractures in Children Under Two Years of Age: Accident or Abuse?**
*Yezmine Chalita, BSC; Augustus M. O'Gorman, MD; Jean-Pierre Farmer, MD; Jose L. Montes, MD (Montreal, PQ, Canada)*

8:35 - 8:45 AM
**3. Subdural Hematomas in Infants with Benign Enlargement of the Subarachnoid Spaces are Not Pathognomonic for Child Abuse**
*Daniel McNeely, MD, FRCS(C) (Halifax, NS, Canada); Jean-Pierre Farmer, MD, FRCS(C); Jeffrey Atkinson, MD, FRCS(C); Jose L. Montes, MD, FACS; Gaurav Saigal, MD; Augustin M. O'Gorman, MD (Montreal, PQ, Canada)*

8:45 - 8:55 AM
**4. Neurosurgical Injuries Associated with All-Terrain Vehicles in Pediatric Patients: Our Ten Year Experience**
*Jose A. Menendez, MD; Francesco T. Mangano, DO; Prithvi Narayan, MD; Matthew Smyth, MD; Jeffrey Leonard, MD; Tae Sung Park, MD (St. Louis, MO)*

8:55 - 9:05 AM
**5. Predictors of Early Clinical Outcome in Pediatric Minor Head Injury**
*Jeffrey D. Atkinson, MD, FRCS(C); Debbie Friedman, PT; Jose L. Montes, MD, FACS; Jean-Pierre Farmer, MD, FRCS(C) (Montreal, PQ, Canada)*

9:05 - 9:15 AM
**6. "Moving Target" MRI for Evaluation of Head Trauma in Unsedated Children: Experimental Studies Using Large Animal Models**
*Dimitrios Nikas, MD; Alex Mamourian, MD; Ann-Christine Duhaime, MD (Lebanon, NH)*

9:15 - 9:25 AM
**7. The Value of Limiting Radiographic Evaluation for Detection of Pediatric Spinal Cord Injury**
*Stephanie Greene, MD; Mark R. Proctor, MD; Eric J. Woodard, MD; Dennis L. Johnson, MD (Boston, MA)*

9:25 - 9:35 AM
**8. Cervical Spine Clearance after Trauma in the Pediatric Population**
Richard C. E. Anderson, MD (New York, NY); Kris W. Hansen, RN; Douglas L. Brockmeyer, MD (Salt Lake City, UT)

9:35 - 9:45 AM
**9. Maturation-dependent Response to Traumatic Subdural Hematoma in the Immature Porcine Brain**
*Susan R. Durham, MD; Richard Traystman, PhD (Portland, OR); Ann-Christine Duhaime, MD (Lebanon, NH)*

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9:45 – 10:15 AM
BEVERAGE BREAK IN THE EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse Level



## THURSDAY, DECEMBER 9 (CONT'D)

10:15 - 11:25 AM
SPECIAL TOPIC I
Pediatric Head Injury
Grand Ballroom A-Street Level
*Moderator: Ann-Christine Duhaime, MD*

Learning Objectives
Upon completion of this program, participants should be able to:

- Describe the guidelines for pediatric head injuries.
- Recognize the biological basis of head injuries.
- Apply practical considerations for therapy of pediatric head injury.

Guidelines for Pediatric Head Injury
*P. David Adelson, MD, FACS*

Biological Basis of CNS Trauma and Future Directions
*David A. Hovda, PhD*

Practical Considerations for Therapy
*Thomas G. Luerssen, MD*

11:25 - 11:30 AM
PRESENTATION OF LIFETIME ACHIEVEMENT AWARD TO FRED J. EPSTEIN, MD
*Presented by Rick Abbott, MD*

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11:30 AM - 12:30 PM
SCIENTIFIC SESSION II
Spine
Grand Ballroom A-Street Level
*Moderators: Douglas L. Brockmeyer, MD; Peter P. Sun, MD*

Learning Objectives
Upon completion of this program, participants should be able to:

- Compare outcomes and current strategies for pediatric spinal disorders.
- Identify the indications and results of C1 - 2 surgical fixation.

11:30 - 11:40 AM
**10. C1-2 Transarticular Screw Fixation: A Review of 74 Pediatric Patients for Surgical Indication, Fusion Rate, Complications, and Lessons Learned**
*Wayne M. Gluf, MD; Douglas L. Brockmeyer, MD (Salt Lake City, UT)*

11:40 – 11:50 AM
**11. Long term Maintenance of Cervical Alignment after Occipital Cervical Fusion in Pediatric Patients**
*Richard C. E. Anderson, MD (New York, NY)*

11:50 AM - 12:00 PM
**12. Microdiscectomy vs. Conservative Management of Pediatric Disc Disease: Outcomes in the Modern Era**
*Kevin L. Stevenson, MD; Roger J. Hudgins, MD; William R. Boydston, MD, PhD; Andrew Reisner, MD; Cathy Frysh, PA-C (Atlanta, GA)*

12:00 - 12:10 PM
**13. Multilevel Cervical Disconnection Anomaly - Initial Description, Embryogenesis and Management**
*Paul Klimo, MD, MPH; Richard Anderson, MD, UT; Douglas L. Brockmeyer, MD (Salt Lake City, UT)*

12:10 - 12:20 PM
**14. CT Image Segmentation and 3-D Reconstruction for Evaluation of Occipital-Cervical Instability in Children**
*Samuel R. Browd, MD, PhD; Lindsey McAninch; Greg Jones, PhD; Douglas L. Brockmeyer, MD (Salt Lake City, UT)*

12:20 - 12:30 PM
**15. High Frequency Radiosurgery: Surgical Adjunct for Lumbosacral Lipoma Resection and Spinal Cord Detethering**
*Anders J. Cohen, DO; Steven J. Schneider, MD (New York, NY)*

12:30 – 1:30 PM
LUNCH & POSTER VIEWING IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse Level

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1:30 - 3:00 PM
SCIENTIFIC SESSION III
Congenital Anomalies
Grand Ballroom A-Street Level
*Moderators: Timothy M. George, MD; Dachling Pang, MD*

Learning Objectives
Upon completion of this program, participants should be able to:

- Describe the treatment options for spinal cord lipomas.
- Discuss functional outcomes in patients with spina bifida.
- Recognize treatment of movement disorders.

1:30 - 1:40 PM
**16. Conservative Management of Asymptomatic Spinal Lipomas of the Conus**
*Abhaya V. Kulkarni, MD, FRCS (Toronto, ON, Canada); Alain Pierre-Kahn; Michel Zerah (Paris, France)*

1:40 - 1:50 PM
**17. The Need for a New Theory of Lipomyelomeningocele Formation**
*Timothy M. George, MD; Thomas J. Cummings, MD (Durham, NC)*

1:50 - 2:00 PM
**18. Supra-placode Spinal Cord Transection for Paraplegic Patients with Myelodysplasia and Repetitive Symptomatic Tethered Spinal Cord**
*Elizabeth C. Tyler-Kabara, MD, PhD; R. S. Tubbs, PhD, PA-C; John C. Wellons III, MD; Jeffrey P. Blount, MD; W. Jerry Oakes, MD, (Birmingham, AL)*

2:00 - 2:10 PM
**19. Spinal Cord Epidermoids following Fetal Surgery for Myelomeningocele: Clinical Correlations and Follow-up**
*Leslie N. Sutton, MD (Philadelphia, PA); Ian F. Pollack, MD (Pittsburgh, PA); Gerald Tuite, MD (St. Petersburg, FL); Arnold Menezes, MD (Iowa City, IA); Leland Albright, MD (Pittsburgh, PA)*

2:10 - 2:20 PM
**20. Myelomeningoceles and Meconium**
*Josephine Wyatt-Ashmead, MD; Andrew Parent, MD; John Lancon, MD; Amanda Ellis, RN; James Bofill, MD; Steven Bigler, MD; Alexandra Ashmead (Jackson, MS)*

2:20 - 2:30 PM
**21. The Difference in Clinical Outcome in Patients with Terminal Myelocystocele With or Without Abdominal Defects**
*Hector E. James, MD (Jacksonville, FL)*

2:30 - 2:40 PM
**22. Falling CSF Shunt Rates for Myelomeningocele in Canada**
*Patrick J. McDonald, MD, FRCS(C) (Winnipeg, MB, Canada); James M. Drake, MD, FRCS(C); Maria Lamberti-Pasculli, RN; James T. Rutka, MD, FRCS(C); Robin P. Humphreys, MD, FRCS(C); Peter B. Dirks, MD, FRCS(C) (Toronto, ON, Canada)*

2:40 - 2:50 PM
**23. Familial Relationship between Chiari 0 and Chiari I**
*Roham Moftakhar, MD (Madison, WI); Marcy C. Speer, MD (Durham, NC); R. Shane Tubbs, PhD; W. Jerry Oakes, MD (Birmingham, AL); Bermans J. Iskandar, MD (Madison, WI)*

2:50 - 3:00 PM
**24. Posterior Cranial Fossa Volume in Patients with Rickets: Insights into the Increased Occurrence of Chiari I Malformation in Metabolic Bone Disease**
*Elizabeth C. Tyler-Kabara, MD, PhD; R. S. Tubbs, PhD, PA-C; John C. Wellons III, MD; Jeffrey P. Blount, MD; W. Jerry Oakes, MD, (Birmingham, AL)*

3:00 – 3:30 PM
BEVERAGE BREAK IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse

# PROGRAM SCHEDULE

## THURSDAY, DECEMBER 9 (CONT'D)

3:30 - 4:30 PM
SPECIAL TOPIC II
Controversies: Tethered Spinal Cord
Grand Ballroom A-Street Level
*Moderator: Paul Steinbok, MD*

Learning Objectives
Upon completion of this program, participants should be able to:

- Describe the patterns of urological abnormalities associated with tethered spinal cord.
- Compare the treatment approaches for patients with tethered spinal cord.

The Role for Urodynamics
*Laurence S. Baskin, MD*

Surgery Is Indicated
*Nathan R. Selden, PhD, MD*

Surgery Is Not Indicated
*James M. Drake, MD*

4:30 - 5:45 PM
SCIENTIFIC SESSION IV
Hydrocephalus I
Grand Ballroom A-Street Level
*Moderators: Stephen L. Huhn, MD; David M. Frim, MD, FACS*

Learning Objectives
Upon completion of this program, participants should be able to:

- Evaluate techniques in the treatment of hydrocephalus.
- Evaluate the effects of these techniques on the practice of pediatric neurosurgery.

4:30 - 4:40 PM
**25. Antibiotic-Impregnated Shunt Catheters Decrease the Incidence of Shunt Infection in the Treatment of Hydrocephalus**
*Daniel M. Sciubba, MD; R. M. Stuart, BA; Matthew J. McGirt, MD; Graeme F. Woodworth, BS; Amer F. Samdani, MD; Benjamin Carson, MD; George I. Jallo, MD (Baltimore, MD)*

4:40 - 4:50 PM
**26. International Infant Hydrocephalus Study (IIHS): Study Design and Prospects**
*Shlomo Constantini, MD (Tel Aviv, Israel); Spyros Sgouros, MD (Birmingham, United Kingdom); Abhaya Kulkarni, MD (Toronto, ON, Canada)*

4:50 - 5:00 PM
**27. The Management of Shunt Infection: A Multicenter Pilot Study**
*John R. W. Kestle (Salt Lake City, UT); Hugh Garton (Ann Arbor, MI); William Whitehead (Indianapolis, IN); James Drake; Abhaya Kulkarni (Toronto, ON, Canada)*

5:00 - 5:10 PM
**28. The Permeable Proximal Catheter Project: A Novel Approach To Preventing Shunt Obstruction**
*Joshua E. Medow, MD (Madison, WI)*

5:10 - 5:20 PM
**29. Programmable Versus Fixed-Pressure Valves for the Treatment of Hydrocephalus in Children**
*Chris Heller, MD; Mark D. Krieger, MD; David I. Sandberg, MD; Bryan C. Oh, MD; J. Gordon McComb, MD (Los Angeles, CA)*

5:20 - 5:30 PM
**30. Craniotomy for Fenestration of Multiloculated Hydrocephalus in Pediatric Patients**
*David I. Sandberg, MD; J. Gordon McComb; Mark D. Krieger (Los Angeles, CA)*

5:30 - 5:45 PM
UPDATE: THE MANAGEMENT OF MYELOMENINGOCELE STUDY (MOMS): THE FIRST 20 MONTHS
*Invited Speaker: Catherine Shaer, MD (Baltimore, MD)*

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5:45 - 6:15 PM
ANNUAL BUSINESS MEETING
Grand Ballroom A-Street Level

6:15 – 7:15 PM
RECEPTION HONORING THE LIFETIME ACHIEVEMENT AWARD WINNER-FRED J. EPSTEIN, MD
Garden Room-Atrium Level

## OPEN EVENING

## FRIDAY, DECEMBER 10

7:00 – 8:00 AM
CONTINENTAL BREAKFAST IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse Level

7:00 AM – 6:30 PM
EXHIBIT & POSTER VIEWING IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse Level

7:00 AM – 5:30 PM
REGISTRATION
Grand Ballroom A Foyer-Street Level

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8:00 - 9:30 AM
SCIENTIFIC SESSION V
Tumors
Grand Ballroom A–Street Level
*Moderators: Jeffrey H. Wisoff, MD; Liliana C. Goumnerova, MD, FRCSC*

Learning Objectives
Upon completion of this program, participants should be able to:

- Cite treatment and outcomes for common and uncommon pediatric brain tumors.
- Understand the role of new MR imaging modalities in the diagnosis of pediatric brain tumors.

8:00 - 8:10 AM
**31. Phase II Trial of Conformal Radiation Therapy for Pediatric Patients with Craniopharyngioma and Correlation of Radiation Dosage with Change in Cognitive Function**
*Thomas Merchant, DO, PhD; Erin Kiehna, BS; Larry Kun, MD; Raymond Mulhern, PhD; Cheng Hong Li, MD; Xiaoping Xiong, MD; Fredrick Boop, MD; Robert A. Sanford, MD (Memphis, TN)*

8:10 - 8:20 AM
**32. Convection and Diffusion Distributed Anti-glioma Monoclonal Antibody 8H9 in the Brain following Interstitial Infusion**
*Neal Luther; William J. Ryder; Nai-Kong Cheung, MD, PhD; Philip H. Gutin, MD; Mark M. Souweidane, MD (New York, NY)*

8:20 - 8:30 AM
**33. Pediatric PNETs: Effects of Surgical and Adjuvant Therapy on Patterns of Recurrence and Progression**
*P. Ryan McGarry; J. Gordon McComb, MD; Ira Bowen; Mark D. Krieger, MD (Los Angeles, CA)*

8:30 - 8:40 AM
**34. Diffusion-Weighted MR Imaging in Pediatric Patients with Surgically-Treated Intracranial Neoplasms**
*Justin S. Smith, MD, PhD; Henry Lin, BA; Katie Mayo, BA; Anuradha Banerjee, MD; Nalin Gupta, MD, PhD; Victor Perry, MD; Soonmee Cha, MD (San Francisco, CA)*

8:40 - 8:50 AM
**35. Differentiation of Pediatric Cerebral Neoplasms by Advanced Magnetic Resonance Spectroscopy**
*Mark D. Krieger, MD; J. Gordon McComb, MD; Marvin D. Nelson, MD; Ashok Panigrahy, MD; Ignacio Gonzalez-Gomez, MD; Floyd Gilles, MD; Stefan Bluml, PhD (Los Angeles, CA)*

8:50 - 9:00 AM
**36. Pediatric Posterior Fossa Tumors: Preoperative Predictors of Chronic Hydrocephalus**
*Jay K. Riva-Cambrin, MD (Toronto, ON, Canada)*

9:00 - 9:10 AM
**37. Cumulative Incidence of Radiation-Induced Lesions of Magnetic Susceptibility in Children with Medulloblastomas**
*Sean M. Lew, MD; Joseph N. Morgan, MD; Estee Psaty; Daniel R. Lefton, MD; Jeffrey Allen, MD; Rick Abbott, MD (New York, NY)*



## FRIDAY, DECEMBER 10 (CONT'D)

9:10 - 9:20 AM
**38. Oculomotor Abnormalities are Common after Resection of Midline Posterior Fossa Tumors**
*Jeffrey G. Ojemann, MD; James O. Phillips, PhD; Richard G. Ellenbogen, MD; Anthony M. Avellino, MD; Avery H. Weiss, MD (Seattle, WA)*

9:20 - 9:30 AM
**39. Supraciliary Approach for Anterior Cranial Fossa Lesions in Children**
*George I. Jallo, MD (Baltimore, MD); Lazlo Bognar, MD (Budapest, Hungary)*

9:30 – 10:00 AM
BEVERAGE BREAK IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse

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10:00 - 11:10 AM
SCIENTIFIC SESSION VI
Hydrocephalus II
Grand Ballroom A-Street Level
*Moderators: John R. W. Kestle, MD, MSc; Frederick A. Boop, MD, FACS*

Learning Objectives
Upon completion of this program, participants should be able to:

- Identify new treatment strategies for complex hydrocephalus.
- Discuss the role for imaging adjuncts in the management of hydrocephalus.

10:00 - 10:10 AM
**40. Use of Lumbar Shunt in Management of Patients with Slit Ventricles and Recurrent Ventricular Shunt Malfunction**
*Sandeep Sood, MD; Tiffany Powell, BS; Ryan Barrett, DO (Detroit, MI)*

10:10 - 10:20 AM
**41. Diagnosis and Management of Pediatric Pseudotumor Cerebri**
*Frederick A. Boop, MD, FACS; Robert A. Sanford, MD; Stephanie Einhaus, MD, DMSc; Michael Muhlbauer, MD (Memphis, TN)*

10:20 - 10:30 AM
**42. Genetic Influences Driving the Closure of the Cerebral Aqueduct in Congenital Hydrocephalus**
*Janet M. Miller, PhD; Gary S. Krause, MD; Steven D. Ham, DO; James P. McAllister II, PhD (Detroit, MI)*

10:30 - 10:40 AM
**43. Can the Skull Diploic Space be Utilized for Absorption of Cerebrospinal Fluid?**
*Jeffrey Pugh, MD; Keith Aronyk, MD (Edmonton, AB, Canada)*

10:40 – 10:50 AM
**44. Role of SPECT Scanning in Pediatric Hydrocephalus**
*Deepak Agrawal; Pralay K. Nayak; C.S. Bal; Ashok K. Mahapatra (New Delhi, India)*

10:50 - 11:00 AM
**45. Computed Tomography Based Ventricular Volume Measurement in Radiographically Occult Shunt Malfunction**
*Prithvi Narayan, MD; Avi Mazumdar, MD; Dennis Rivet, MD; Jeffrey R. Leonard, MD; Tae Sung Park, MD; Ben Lee, MD; Matthew D. Smyth, MD (St. Louis, MO)*

11:00 - 11:10 AM
**46. Chemical Analysis of Fluid Obtained From Intracranial Arachnoid Cysts in Pediatric Patients**
*David I. Sandberg, MD; J. Gordon McComb, MD; Mark D. Krieger, MD (Los Angeles, CA)*

11:10 - 11:20 AM
UPDATE: THE HYDROCEPHALUS ASSOCIATION DATABASE
Grand Ballroom A-Street Level
*Yvonne W. Wu, MD (San Francisco, CA)*

11:25 - 11:30 AM
INTRODUCTION OF THE RAIMONDI LECTURER
Grand Ballroom A-Street Level
*Nalin Gupta, MD, PhD; Mitchel S. Berger, MD, FACS*

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11:30 AM - 12:30 PM
RAIMONDI LECTURE
Medical Science Then and Now: The Personal View of a Cancer Scientist
*J. Michael Bishop, MD*
Grand Ballroom A-Street Level

12:30 – 1:30 PM
LUNCH AND POSTER VIEWING IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse Level

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1:30 - 3:00 PM
SCIENTIFIC SESSION VII
Vascular and Craniofacial Anomalies
Grand Ballroom A-Street Level
*Moderators: R. Michael Scott, MD; Mark D. Krieger, MD*

Learning Objective
Upon completion of this program, participants should be able to:

- Discuss new information on vascular malformations and aneurysms in children.

1:30 - 1:40 PM
**47. Elevation of CRABP-I in the Cerebrospinal Fluid of Moyamoya Disease Patients**
*Seung-Ki Kim, MD, PhD; Jong-Il Yoo; Byung-Kyu Cho, MD, PhD; Soo Jin Hong; Yong-Kook Kim; Jung-Ae Moon; Ji Ha Kim, MD; You-Nam Chung, MD, PhD; Kyu-Chang Wang, MD, PhD (Seoul, Republic of Korea)*

1:40 - 1:50 PM
**48. Pediatric Intracranial Aneurysms: Durability and Treatment Following Microsurgical and Endovascular Management**
*Nader Sanai, MD; Alfredo Quinones-Hinojosa, MD; Nalin M. Gupta, MD, PhD; Charles B. Wilson, MD; Christopher F. Dowd, MD; Victor L. Perry, MD; Michael L. Lawton, MD (San Francisco, CA)*

1:50 - 2:00 PM
**49. Microsurgical Treatment of Pediatric Arteriovenous Malformations: Recent UCSF Experience**
*Rene O. Sanchez-Mejia, MD (San Francisco, CA); Sravana Chennupati, AB MS (Berkeley, CA); Nalin Gupta, MD, PhD; Victor Perry, MD; Michael W. McDermott, MD; Michael T. Lawton, MD (San Francisco, CA)*

2:00 - 2:10 PM
**50. Delayed Repair of Scaphocephaly: Significance of Intracranial Pressure**
*Robert F. Keating, MD; Jonathan Martin, MD; Michael Boyajian, MD; Jeffery Posnick, DMD, MD; Derek Bruce, MD (Washington, DC)*

2:10 - 2:20 PM
**51. Developmental Delays in Children with Deformational Plagiocephaly: An Updated Report**
*Jayesh Panchal, MD, FRCS; Robin Gurwitch; Shaurin Patel; Paul Francel; John Honeycutt (Oklahoma City, OK)*

2:20 - 2:30 PM
**52. Correlation of Head Shape vs. Cephalic Index for Measuring Outcomes for Sagittal Craniosynostosis.**
*Jayesh Panchal, MD, FRCS; Mike Dixon; Donna Tepper; Don Parker; Christie Burgin; John Honeycutt; Paul Francel (Oklahoma City, OK)*

2:30 - 2:40 PM
**53. The Risk of CSF Rhinorrhea in Craniofacial Surgery**
*Glenn Morrison, MD; Stephen Anthony Wolfe; John Ragheb (Miami, FL)*

2:40 - 2:50 PM
**54. Microscopic Approach to Cranosynostosis**
*James E. Baumgartner, MD; John F. Teichgraeber, MD (Houston, TX)*

# PROGRAM SCHEDULE

2:50 - 3:00 PM
**55. Delayed Multisutural Synostosis: Clinical Features and Surgical Correction**
*Khaled B. Aly, MD; Ashraf H. Abolnasr, MD; Ahmed Zaatar, MD; Ashraf ElSellawy, MD (Giza, Egypt)*

3:00 – 3:30 PM
BEVERAGE BREAK IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse Level

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3:30 - 4:30 PM
SPECIAL TOPIC III
**Review Topic: Advances in Diagnostic and Interventional Neuroimaging**
Grand Ballroom A-Street Level
*Moderator: Nalin Gupta, MD, PhD*

Learning Objectives
- Explain the use of MED-DTI in brain tumors.
- Describe perfusion and spectroscopic MR imaging.
- Describe endovascular management of Vein of Galen malformations.

**MEG-DTI for Presurgical Mapping of Pediatric Brain Lesions**
*Pratik Mukherjee, MD*

**Perfusion and Spectroscopic Imaging of Brain Tumors**
*Soonmee Cha, MD*

**Current Endovascular Management of Vein of Galen Malformations**
*Christopher F. Dowd, MD*

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4:30 - 5:30 PM
SCIENTIFIC SESSION VIII
**Functional and Epilepsy**
Grand Ballroom A-Street Level
*Moderators: Bermans J. Iskandar, MD; Warwick J. Peacock, MD*

Learning Objectives
Upon completion of this program, participants should be able to:
- Predict anticipated seizure control following resective surgery.
- Review common complications following epilepsy surgery.

4:30 - 4:40 PM
**56. Vagus Nerve Stimulation for Induced Spinal Cord Seizures: Insights into Seizure Cessation**
*Elizabeth C. Tyler-Kabara, MD, PhD; R. Shane Tubbs, PhD, PA-C; Jeffrey P. Blount, MD; John C. Wellons III, MD; W. Jerry Oakes, MD (Birmingham, AL)*

4:40 - 4:50 PM
**57. Epilepsy Surgery in Young Children**
*Andrea Douglas; Nicholas Post; Josianne LaJoie; Daniel Miles; Orrin Devinsky; Howard L. Weiner, MD (New York, NY)*

4:50 - 5:00 PM
**58. Surgical Management of Refractory Nonlesional Extratemporal Epilepsy in the Pediatric Population**
*Sanjiv Bhatia, MD; Glenn Morrison, MD, FACS; John R. Ragheb, MD, FACS; Catalina Dunoyer, MD; Michael Duchowny, MD; Trevor Resnick, MD; Prasanna Jayakar, MD, PhD; (Miami, FL)*

5:00 - 5:10 PM
**59. Seizure Control in Children with Low Grade Gliomas**
*Raja B. Khan, MD; Fredrick A. Boop, MD; Robert A. Sanford, MD (Memphis, TN)*

5:10 - 5:20 PM
**60. Complications of Invasive Subdural Grid and Strip Electrode Monitoring at Saint Louis Children's Hospital, 1994-2004**
*James M. Johnston Jr., MD; Francesco Mangano, DO; Susan T. Arnold, MD; T. S. Park, MD (St. Louis, MO); Jeffrey G. Ojemann, MD (Seattle, WA); Liu Lin Thio, MD, PhD; Edwin Trevathan, MD, MPH; Michael Wong, MD, PhD; John M. Zempel, MD, PhD; Jeffrey Leonard, MD; Matthew D. Smyth, MD (St. Louis, MO)*

5:20 - 5:30 PM
**61. Progression of Scoliosis after Baclofen Pump Placement**
*Mark J. Puccioni, MD (Omaha, NE); Dale Swift, MD (Dallas, TX)*

5:30 - 6:30 PM
WINE & CHEESE RECEPTION IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse (Open to Medical Registrants)

## SATURDAY, DECEMBER 11

7:00 – 8:00 AM
CONTINENTAL BREAKFAST IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse

7:00 – 10:00 AM
REGISTRATION
Grand A Foyer-Street Level

7:00 – 11:00 AM
EXHIBIT & POSTER VIEWING IN EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse

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8:00 - 9:30 AM
SCIENTIFIC SESSION IX
**Endoscopic Procedures**
Grand Ballroom A-Street Level
*Moderators: Alan R. Cohen, MD; Saadi Ghatan, MD*

Learning Objectives
Upon completion of this program, participants should be able to:
- Identify CNS diseases amenable to endoscopic procedures.
- Discuss risks and benefits of endoscopic procedures.

8:00 - 8:10 AM
**62. Endoscopic Surgery of Hypothalamic Hamartoma (HH) Associated with Refractory Catastrophic Epilepsy in Pediatric Patients**
*Iman Feiz-Erfan, MD; Eric M. Horn, MD, PhD; Harold L. Rekate, MD; Yu-tze Ng, MD; Jeffrey D. Klopfenstein, MD; L. Fernando Gonzalez, MD; Gregory P. Lekovic, MD, JD; John F. Kerrigan, MD (Phoenix, AZ)*

8:10 - 8:20 AM
**63. Feasibility of the Endonasal Transsphenoidal Approach in the Treatment of Pituitary Tumors in Children**
*Marcus L. Ware, MD; Charles B. Wilson, MD; Sandeep Kunwar, MD (San Francisco, CA)*

8:20 - 8:30 AM
**64. Low-Frontal Transventricular Endoscopic Approach to the Pineal Region**
*Jonathan E. Martin, MD (Honolulu, HI); James M. Ecklund, MD; Robert F. Keating, MD (Washington, DC)*

8:30 - 8:40 AM
**65. Endoscopic Resection of Solid Intraventricular Tumors**
*Neal Luther; Mark M. Souweidane, MD (New York, NY)*

8:40 - 8:50 AM
**66. The Role of Endoscopic Minimally Invasive Craniotomy for the Treatment of Scaphocephaly**
*Ian M. Heger, MD; Eric Stelnicki, MD; Drew Schnitt, MD; Luis Rodriguez, MD (Hollywood, FL)*

8:50 - 9:00 AM
**67. Endoscopic Management of Supratentorial Intra and Paraventricular Cysts**
*Gianpiero Tamburrini, MD; Massimo Caldarelli, MD; Luca Massimi, MD; Rossana Romani, MD; Griselda Ramirez-Reyes, MD; Concezio Di Rocco, MD (Rome, Italy)*

9:00 - 9:10 AM
**68. Should Endoscopic Third Ventriculostomy be the Primary Treatment for Pediatric Hydrocephalus in the Sudan**
*John Thorne, MD; Jerard Ross (Salford Manchester, United Kingdom); Aziza El Naeema, Sobeh (Khartoum, Sudan); Carys Bannister (Manchester, United Kingdom)*





## SATURDAY, DECEMBER 11 (CONT'D)

9:10 - 9:20 AM
**69. Hemmorhagic Sequelae of Endoscopic Surgery for Intraventricular Tumors in the Pediatric Population**
*Anders J. Cohen, DO; Mark M. Souweidane, MD (New York, NY)*

9:20 - 9:30 AM
**70. Continuous Spinal Drain following Endoscopic 3rd Ventriculostomy: Changing the Definition of Failure**
*Shlomo Constantini, MD; Pinar Ozisik, MD; Jonathan Roth, MD; Liana Beni-Adani, MD (Tel Aviv, Israel)*

9:30 - 10:00 AM
SPECIAL LECTURE
**The Future of Fetal Surgery**
Grand Ballroom A-Street Level
*Michael R. Harrison, MD (San Francisco, CA)*

10:00 – 10:30 AM
BEVERAGE BREAK IN THE EXHIBIT HALL
Pacific Concourse D-O–Pacific Concourse Level

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10:30 AM - 12:00 PM
SCIENTIFIC SESSION X
**General Interest**
Grand Ballroom A-Street Level
*Moderators: Victor L. Perry, MD; Ann Marie Flannery, MD, FACS, FA*

Learning Objective
Upon completion of this program, participants should be able to:
- Recognize recent techniques and technical advances in a variety of pediatric neurosurgical practices.

10:30 - 10:40 AM
**71. Strategy for Coping with the New Neurosurgical Residency 80 Hour Work Week in a Busy Pediatric Emergency Department**
*Stephanie L. Einhaus, MD; Michael Muhlbauer, MD; Frederick Boop, MD; Robert Sanford, MD (Memphis, TN)*

10:40 - 10:50 AM
**72. The Adult Practice of Pediatric Neurosurgery: Clinical, Referral, and Financial Issues**
*David Frim, MD, PhD; Rita Martin-Douglas, MBA (Chicago, IL)*

10:50 - 11:00 AM
**73. Impact of a Nurse Pracitioner on a Pediatric Neurosurgical Service**
*Judie Holleman, MSN, RN; David Frim, MD, PhD (Chicago, IL)*

11:00 - 11:10 AM
**74. Virtual Reality as a Training Tool for Endoscopic Neurosurgical Procedures**
*Sunil Manjila, MD; M. Cenk Cavusoglu, PhD; Nathan Brown; Alan R. Cohen, MD (Cleveland, OH)*

11:10 - 11:20 AM
**75. Use of Rapid MRI Techniques in Unsedated Children**
*Patricia B. Quebada, MD; Alex Mamourian, MBA; Reyaad Hayek; Ann-Christine Duhaime, MD (Lebanon, NH)*

11:20 - 11:30 AM
**76. Heparin Binding Epidermal Growth Factor (HB-EGF) Overexpression is Implicated in the Development of Hydrocephalus in Transgenic Mice**
*Bart A. MacDonald, MD; Gerhard Raab, PhD; Katshutoshi Goishi, MD, PhD; Sun Yanping, PhD; Eichiro Nishi, PhD; Nina Irwin, PhD; Michael Klagsbrun, PhD; Joseph R. Madsen, MD (Boston, MA)*

11:30 - 11:40 AM
**77. Characterization of Murine CD133+ Cerebellar Stem Cells and Murine Medulloblastoma Stem Cells**
*Sharon Chiappa, PhD; Corey Raffel, MD, PhD (Rochester, MN)*

11:40 - 11:50 AM
**78. The Efficacy of Duragen as a Dural Substitute Following Chiari Decompression**
*Shabbar F. Danish, MD; Amer Samdani, MD; Amgad Hanna, MD; Michael F. Stiefel, MD, PhD; Phillip Storm, MD; Leslie Sutton, MD (Philadelphia, PA)*

11:50 AM - 12:00 PM
**79. Proper Selection Criteria For Surgical Management of Birth Related Brachial Plexus Palsy**
*Keyne K. Thomas, MD; Richard D. Goldner, MD; Timothy M. George, MD (Durham, NC)*

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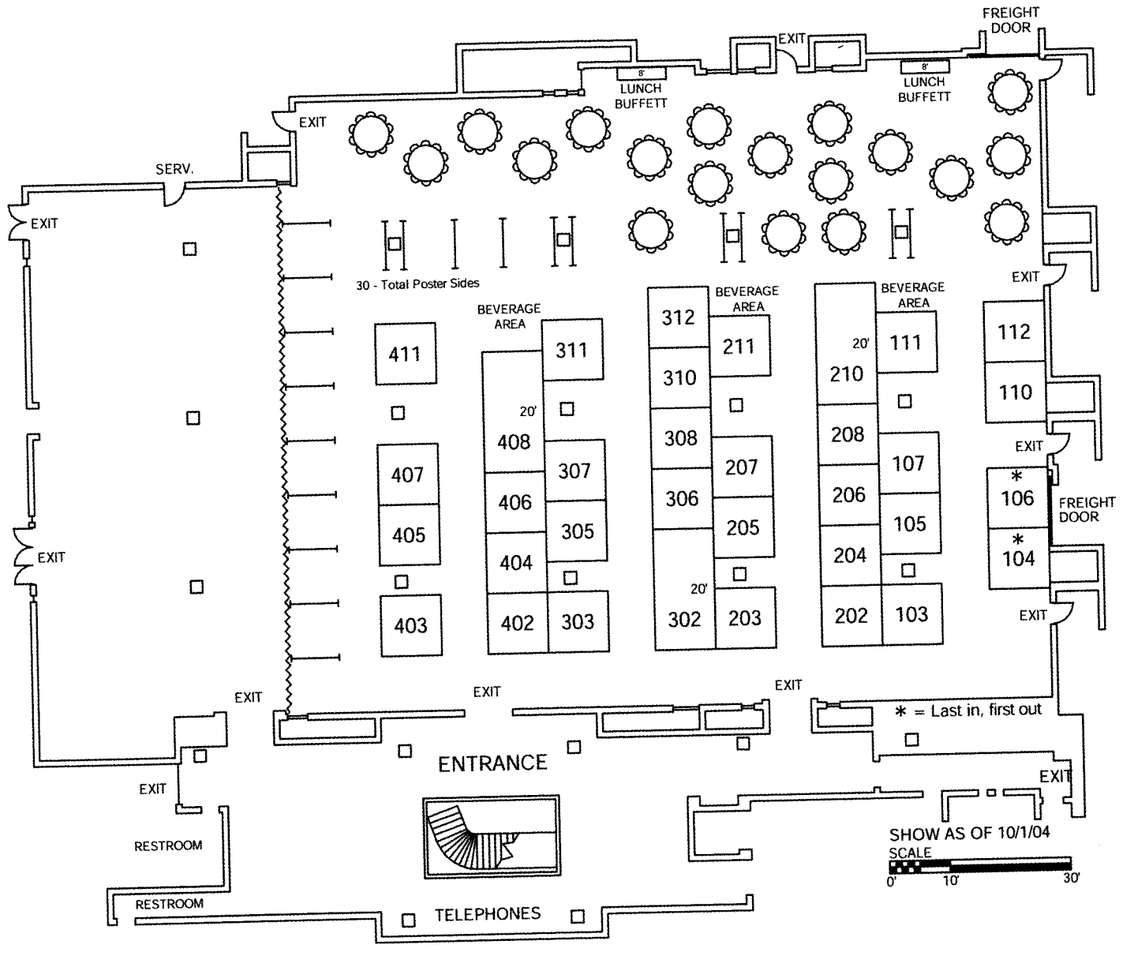
PRESENTATION OF THE HYDROCEPHALUS ASSOCIATION AWARD

12:00 - 12:05 PM
CLOSING REMARKS
*Nalin Gupta, MD, PhD*

# EXHIBIT HALL FLOOR PLAN






# EXHIBITOR LISTING

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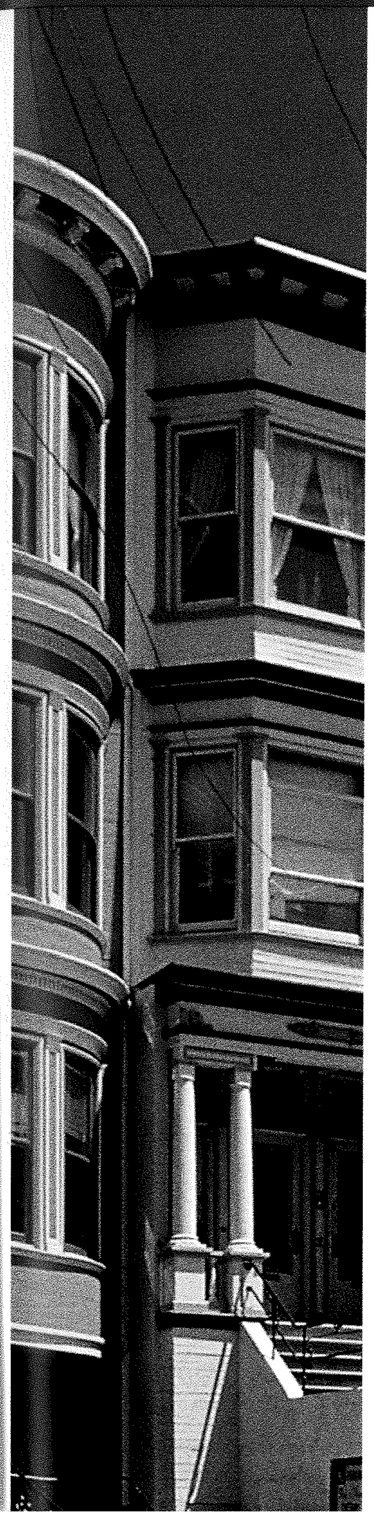

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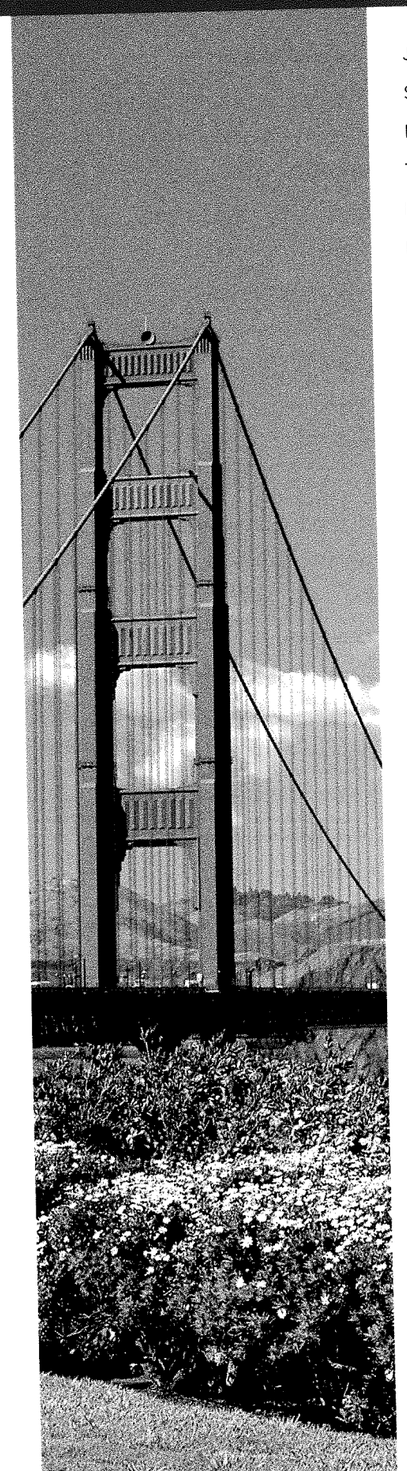

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# ORAL ABSTRACT INDEX

# ORAL ABSTRACT INDEX

21. THE DIFFERENCE IN CLINICAL OUTCOME IN PATIENTS WITH TERMINAL MYELOCYSTOCELE WITH OR WITHOUT ABDOMINAL DEFECTS

*Hector E. James, MD (Jacksonville, FL)*

22. FALLING CSF SHUNT RATES FOR MYELOMENINGOCELE IN CANADA

*Patrick J. McDonald, MD, FRCS(C) (Winnipeg, MB, Canada); James M. Drake, MD, FRCS(C); Maria Lamberti-Pasculli, RN; James T. Rutka, MD, FRCS(C); Robin P. Humphreys, MD, FRCS(C); Peter B. Dirks, MD, FRCS(C) (Toronto, ON, Canada)*

23. FAMILIAL RELATIONSHIP BETWEEN CHIARI 0 AND CHIARI I

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24. POSTERIOR CRANIAL FOSSA VOLUME IN PATIENTS WITH RICKETS: INSIGHTS INTO THE INCREASED OCCURRENCE OF CHIARI I MALFORMATION IN METABOLIC BONE DISEASE

*Elizabeth C. Tyler-Kabara, MD, PhD; R. S. Tubbs, PhD, PA-C; John C. Wellons, III, MD; Jeffrey P. Blount, MD; W. Jerry Oakes, MD, (Birmingham, AL)*

25. ANTIBIOTIC-IMPREGNATED SHUNT CATHETERS DECREASE THE INCIDENCE OF SHUNT INFECTION IN THE TREATMENT OF HYDROCEPHALUS

**Hydrocephalus Award Candidate**

*Daniel M. Sciubba, MD; R. M. Stuart, BA; Matthew J. McGirt, MD; Graeme F. Woodworth, BS; Amer F. Samdani, MD; Benjamin Carson, MD; George I. Jallo, MD (Baltimore, MD)*

26. INTERNATIONAL INFANT HYDROCEPHALUS STUDY (IIHS): STUDY DESIGN AND PROSPECTS

*Shlomo Constantini, MD (Tel Aviv, Israel); Spyros Sgouros, MD (Birmingham, United Kingdom); Abhaya Kulkarni, MD (Toronto, ON, Canada)*

27. THE MANAGEMENT OF SHUNT INFECTION: A MULTICENTER PILOT STUDY

*John R. W. Kestle (Salt Lake City, UT); Hugh Garton (Ann Arbor, MI); William Whitehead (Indianapolis, IN); James Drake; Abhaya Kulkarni (Toronto, ON, Canada)*

28. THE PERMEABLE PROXIMAL CATHETER PROJECT: A NOVEL APPROACH TO PREVENTING SHUNT OBSTRUCTION

**Kenneth Shulman Award Candidate**

*Joshua E. Medow, MD (Madison, WI)*

29. PROGRAMMABLE VERSUS FIXED-PRESSURE VALVES FOR THE TREATMENT OF HYDROCEPHALUS IN CHILDREN

*Chris Heller, MD; Mark D. Krieger, MD; David I. Sandberg, MD; Bryan C. Oh, MD; J. Gordon McComb, MD (Los Angeles, CA)*

30. CRANIOTOMY FOR FENESTRATION OF MULTILOCULATED HYDROCEPHALUS IN PEDIATRIC PATIENTS

*David I. Sandberg, MD; J. Gordon McComb; Mark D. Krieger (Los Angeles, CA)*

31. PHASE II TRIAL OF CONFORMAL RADIATION THERAPY FOR PEDIATRIC PATIENTS WITH CRANIOPHARYNGIOMA AND CORRELATION OF RADIATION DOSAGE WITH CHANGE IN COGNITIVE FUNCTION

*Thomas Merchant, DO, PhD; Erin Kiehna, BS; Larry Kun, MD; Raymond Mulhern, PhD; Cheng Hong Li, MD; Xiaoping Xiong, MD; Fredrick Boop, MD; Robert A. Sanford, MD (Memphis, TN)*

32. CONVECTION AND DIFFUSION DISTRIBUTED ANTI-GLIOMA MONOCLONAL ANTIBODY 8H9 IN THE BRAIN FOLLOWING INTERSTITIAL INFUSION

**Kenneth Shulman Award Candidate**

*Neal Luther; William J. Ryder; Nai-Kong Cheung, MD, PhD; Philip H. Gutin, MD; Mark M. Souweidane, MD (New York, NY)*

33. PEDIATRIC PNETS: EFFECTS OF SURGICAL AND ADJUVANT THERAPY ON PATTERNS OF RECURRENCE AND PROGRESSION

*P. Ryan McGarry; J. Gordon McComb, MD; Ira Bowen; Mark D. Krieger, MD (Los Angeles, CA)*

34. DIFFUSION-WEIGHTED MR IMAGING IN PEDIATRIC PATIENTS WITH SURGICALLY-TREATED INTRACRANIAL NEOPLASMS

**Kenneth Shulman Award Candidate**

*Justin S. Smith, MD, PhD; Henry Lin, BA; Katie Mayo, BA; Anuradha Banerjee, MD; Nalin Gupta, MD, PhD; Victor Perry, MD; Soonmee Cha, MD (San Francisco, CA)*

35. DIFFERENTIATION OF PEDIATRIC CEREBRAL NEOPLASMS BY ADVANCED MAGNETIC RESONANCE SPECTROSCOPY

*Mark D. Krieger, MD; J. Gordon McComb, MD; Marvin D. Nelson, MD; Ashok Panigrahy, MD; Ignacio Gonzalez-Gomez, MD; Floyd Gilles, MD; Stefan Bluml, PhD (Los Angeles, CA)*

36. PEDIATRIC POSTERIOR FOSSA TUMORS: PREOPERATIVE PREDICTORS OF CHRONIC HYDROCEPHALUS

**Hydrocephalus Award Candidate**

*Jay K. Riva-Cambrin, MD (Toronto, ON, Canada)*

37. CUMULATIVE INCIDENCE OF RADIATION-INDUCED LESIONS OF MAGNETIC SUSCEPTIBILITY IN CHILDREN WITH MEDULLOBLASTOMAS

*Sean M. Lew, MD; Joseph N. Morgan, MD; Estee Psaty; Daniel R. Lefton, MD; Jeffrey Allen, MD; Rick Abbott, MD (New York, NY)*

38. OCULOMOTOR ABNORMALITIES ARE COMMON AFTER RESECTION OF MIDLINE POSTERIOR FOSSA TUMORS

*Jeffrey G. Ojemann, MD; James O. Phillips, PhD; Richard G. Ellenbogen, MD; Anthony M. Avellino, MD; Avery H. Weiss, MD (Seattle, WA)*



39. SUPRACILIARY APPROACH FOR ANTERIOR CRANIAL FOSSA LESIONS IN CHILDREN

*George I. Jallo, MD (Baltimore, MD); Lazlo Bognar, MD (Budapest, Hungary)*

40. USE OF LUMBAR SHUNT IN MANAGEMENT OF PATIENTS WITH SLIT VENTRICLES AND RECURRENT VENTRICULAR SHUNT MALFUNCTION

*Sandeep Sood, MD; Tiffany Powell, BS; Ryan Barrett, DO (Detroit, MI)*

41. DIAGNOSIS AND MANAGEMENT OF PEDIATRIC PSEUDOTUMOR CEREBRI

*Frederick A. Boop, MD, FACS; Robert A. Sanford, MD; Stephanie Einhaus, MD, DMSc; Michael Muhlbauer, MD (Memphis, TN)*

42. GENETIC INFLUENCES DRIVING THE CLOSURE OF THE CEREBRAL AQUEDUCT IN CONGENITAL HYDROCEPHALUS

**Hydrocephalus Award Candidate**

*Janet M. Miller, PhD; Gary S. Krause, MD; Steven D. Ham, DO; James P. McAllister, II, PhD (Detroit, MI)*

43. CAN THE SKULL DIPLOIC SPACE BE UTILIZED FOR ABSORPTION OF CEREBROSPINAL FLUID?

**Hydrocephalus Award Candidate**

*Jeffrey Pugh, MD; Keith Aronyk, MD (Edmonton, AB, Canada)*

44. ROLE OF SPECT SCANNING IN PEDIATRIC HYDROCEPHALUS

**Hydrocephalus Award Candidate**

*Deepak Agrawal; Pralay K. Nayak; C.S. Bal; Ashok K. Mahapatra (New Delhi, India)*

45. COMPUTED TOMOGRAPHY BASED VENTRICULAR VOLUME MEASUREMENT IN RADIOGRAPHICALLY OCCULT SHUNT MALFUNCTION

*Prithvi Narayan, MD; Avi Mazumdar, MD; Dennis Rivet, MD; Jeffrey R. Leonard, MD; Tae Sung Park, MD; Ben Lee, MD; Matthew D. Smyth, MD (St. Louis, MO)*

46. CHEMICAL ANALYSIS OF FLUID OBTAINED FROM INTRACRANIAL ARACHNOID CYSTS IN PEDIATRIC PATIENTS

*David I. Sandberg, MD; J. Gordon McComb, MD; Mark D. Krieger, MD (Los Angeles, CA)*

47. ELEVATION OF CRABP-I IN THE CEREBROSPINAL FLUID OF MOYAMOYA DISEASE PATIENTS

*Seung-Ki Kim, MD, PhD; Jong-Il Yoo; Byung-Kyu Cho, MD, PhD; Soo Jin Hong; Yong-Kook Kim; Jung-Ae Moon; Ji Ha Kim, MD; You-Nam Chung, MD, PhD; Kyu-Chang Wang, MD, PhD (Seoul, Republic of Korea)*

48. PEDIATRIC INTRACRANIAL ANEURYSMS: DURABILITY AND TREATMENT FOLLOWING MICROSURGICAL AND ENDOVASCULAR MANAGEMENT

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*Nader Sanai, MD; Alfredo Quinones-Hinojosa, MD; Nalin M. Gupta, MD; Charles B. Wilson, MD; Christopher F. Dowd, MD; Victor L. Perry, MD; Michael L. Lawton, MD (San Francisco, CA)*

49. MICROSURGICAL TREATMENT OF PEDIATRIC ARTERIOVENOUS MALFORMATIONS: RECENT UCSF EXPERIENCE

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*Rene O. Sanchez-Mejia, MD (San Francisco, CA); Sravana Chennupati, AB MS (Berkeley, CA); Nalin Gupta, MD, PhD; Victor Perry, MD; Michael W. McDermott, MD; Michael T. Lawton, MD (San Francisco, CA)*

50. DELAYED REPAIR OF SCAPHOCEPHALY: SIGNIFICANCE OF INTRACRANIAL PRESSURE

*Robert F. Keating, MD; Jonathan Martin, MD; Michael Boyajian, MD; Jeffery Posnick, DMD MD; Derek Bruce, MD (Washington, DC)*

51. DEVELOPMENTAL DELAYS IN CHILDREN WITH DEFORMATIONAL PLAGIOCEPHALY: AN UPDATED REPORT

*Jayesh Panchal, MD, FRCS; Robin Gurwitch; Shaurin Patel; Paul Francel; John Honeycutt (Oklahoma City, OK)*

52. CORRELATION OF HEAD SHAPE VS. CEPHALIC INDEX FOR MEASURING OUTCOMES FOR SAGITTAL CRANIOSYNOSTOSIS

*Jayesh Panchal, MD, FRCS; Mike Dixon; Donna Tepper; Don Parker; Christie Burgin; John Honeycutt; Paul Francel (Oklahoma City, OK)*

53. THE RISK OF CSF RHINORRHEA IN CRANIOFACIAL SURGERY

**Kenneth Shulman Award Candidate**

*Glenn Morrison, MD; Stephen Anthony Wolfe; John Ragheb (Miami, FL)*

54. MICROSCOPIC APPROACH TO CRANOSYNOSTOSIS

*James E. Baumgartner, MD; John F. Teichgraeber, MD (Houston, TX)*

55. DELAYED MULTISUTURAL SYNOSTOSIS: CLINICAL FEATURES AND SURGICAL CORRECTION.

*Khaled B. Aly, MD; Ashraf H. Abolnasr, MD; Ahmed Zaatar, MD; Ashraf ElSellawy, MD (Giza, Egypt)*

56. VAGUS NERVE STIMULATION FOR INDUCED SPINAL CORD SEIZURES: INSIGHTS INTO SEIZURE CESSATION

*Elizabeth C. Tyler-Kabara, MD, PhD; R. Shane Tubbs, PhD, PA-C; Jeffrey P. Blount, MD; John C. Wellons, III, MD; W. Jerry Oakes, MD (Birmingham, AL)*

57. EPILEPSY SURGERY IN YOUNG CHILDREN

*Andrea Douglas; Nicholas Post; Josianne LaJoie; Daniel Miles; Orrin Devinsky; Howard L. Weiner, MD (New York, NY)*

58. SURGICAL MANAGEMENT OF REFRACTORY NONLESIONAL EXTRATEMPORAL EPILEPSY IN THE PEDIATRIC POPULATION

*Sanjiv Bhatia, MD; Glenn Morrison, MD, FACS; John R. Ragheb, MD, FACS; Catalina Dunoyer, MD; Michael Duchowny, MD; Trevor Resnick, MD; Prasanna Jayakar, MD, PhD (Miami, FL)*

# ORAL ABSTRACT INDEX





# ORAL ABSTRACTS

## 1. DEMOGRAPHICS OF INFANT ABUSIVE HEAD TRAUMA IN PENNSYLVANIA


*Mark S. Dias, MD; Henry Kesler; Michele L. Shaffer, PhD; Neal J. Thomas, MD (Hershey, PA)*


Introduction Virtually nothing is known about the demographics of abusive head injury in infants under 36 months of age except for the general mantra that 'abusive head injury can potentially occur in any segment of society.' We had an opportunity to study the demographics of abusive head injury in this group.

Methods All records of substantiated abusive head injury in infants under 36 months of age were gathered retrospectively from the Child Line database (Pennsylvania Division of Children Youth and Families) and cross referenced to the infants' birth certificates. Data from both documents were abstracted to generate a composite demographic for these infants and their families which was compared with state-wide norms.

Results A total of 327 infants were identified between 1996 and 2002 inclusive representing an incidence of 46.7 cases per year and 32.3 cases per 100,000 live births. Many of the social demographics were statistically different from the state norms. For example, the parents of these infants were younger, less educated, less likely to have been married at the time of the child's birth, and less likely to have sought prenatal care compared with state-wide norms. In contrast, no differences in the 'medical' demographics (such as child's birth weight, parity, complications of pregnancy, method of delivery, or complications of delivery) were found.

Conclusions This, the largest study of the demographics of abusive head injury, suggests that the involved infants and their families have unique demographic features that could be useful in implementing focused prevention efforts.

## 2. SKULL FRACTURES IN CHILDREN UNDER TWO YEARS OF AGE: ACCIDENT OR ABUSE?


*Yezmine Chalita, BSC; Augustus M. O'Gorman, MD; Jean-Pierre Farmer, MD; Jose L. Montes, MD (Montreal, PQ, Canada)*


Introduction Non-linear skull fractures are often thought to be an indication of non-accidental head injury in children under 2 years of age. As a result, families of children who present with this kind of fractures are subjected to the scrutiny of social service and youth protection. The purpose of the study was to show that non-linear skull fractures can also occur regularly as a result of accidental trauma.

Methods Skull radiographs of children up to 2 years of age who were diagnosed with skull fracture at the Montreal Children's Hospital in a 36-month were retrospectively and blindly reviewed by a neuroradiologist. The cases that showed non-linear or multiple skull fractures were selected and further evaluated to determine whether child abuse had been demonstrated. This cohort was then compared to a group of age-matched patients with proven child abuse to look for distinguishing features.

Results Of 127 cases of skull fractures 28 were non-linear or multiple fractures. All 28 were isolated injuries without other evidence of skeletal trauma. Nine had CT findings of ipsilateral small subdural or epidural collections. Twenty-eight had social service investigations ruling out child abuse. In the non-accidental group, of a total of 11 patients only three had linear, single fractures. Nine of these patients had associated skeletal injuries at presentation and one had retinal hemorrhages.

Conclusions Non-linear skull fractures in isolation are not pathognomonic of non-accidental trauma. In the absence of other classical injuries at presentation, the suspicion of child abuse should be appropriately weighted.

## 3. SUBDURAL HEMATOMAS IN INFANTS WITH BENIGN ENLARGEMENT OF THE SUBARACHNOID SPACES ARE NOT PATHOGNOMONIC FOR CHILD ABUSE


*Daniel McNeely, MD, FRCS(C) (Halifax, NS, Canada); Jean-Pierre Farmer, MD, FRCS(C); Jeffrey Atkinson, MD, FRCS(C); Jose L. Montes, MD, FACS; Gaurav Saigal, MD; Augustin M. O'Gorman, MD (Montreal, PQ, Canada)*


Introduction Patients who have benign enlargement of the subarachnoid spaces have long been suspected of having an increased propensity for subdural hematomas either spontaneously or as a result of accidental injury. Subdural hematomas in infants are often equated with child abuse. The purpose of this study is to describe the clinical and imaging characteristics of subdural hematomas that occur either spontaneously or as a result of accidental injury in infants with benign enlargement of the subarachnoid spaces.

Methods A retrospective review of all patients with benign enlargement of the subarachnoid spaces complicated by subdural hematomas evaluated at our institution from 1998 to 2004 was performed. Data concerning the patient's clinical presentation, physical findings, imaging, and management are described.

Results During the study period, seven patients with benign enlargement of the subarachnoid spaces complicated by subdural hematoma were identified. Their mean age at identification of the subdural hematoma was 7.4 months of age. In five cases there was no recognized trauma prior to identification of the subdural hematoma. In three cases, baseline computed tomography (CT) or magnetic resonance imaging (MRI) was available showing prominent subarachnoid spaces without any evidence of subdural blood.

Conclusions Although suspicious for non-accidental trauma, subdural hematoma can occur in children either spontaneously or as a result of accidental trauma. Caution must be exercised when investigating for child abuse based on the sole presence of subdural hematomas, especially in children who are otherwise well and who have benign enlargement of the subarachnoid spaces.

## 4. NEUROSURGICAL INJURIES ASSOCIATED WITH ALL-TERRAIN VEHICLES IN PEDIATRIC PATIENTS: OUR TEN YEAR EXPERIENCE


*Jose A. Menendez, MD; Francesco T. Mangano, DO; Prithvi Narayan, MD; Matthew Smyth, MD; Jeffrey Leonard, MD; Tae Sung Park, MD (St. Louis, MO)*

# ORAL ABSTRACTS

Introduction All-Terrain Vehicles (ATV) have been described as inherently unstable vehicles and are associated with injuries to children during accidents. The purpose of this study is to analyze our experience with neurosurgical injuries sustained during ATV-related accidents.

Methods A retrospective analysis of all admissions to the St. Louis Children's Hospital due to ATV-related accidents between 1993 and 2003 was performed. All patients with a neurosurgical injury were included.

Results 185 patients were admitted as a result of ATV accidents. There were 62 patients that suffered a neurosurgical injury. 42 were male and 20 female ranging from ages 3 to 17. Most common injuries were skull fractures (32 patients) and closed head injuries (30 patients). 21 patients had intracranial hemorrhages and 11 spine fractures. There were 11 neurosurgical procedures performed in these patients, including six craniotomies for elevation of depressed fractures, three craniotomies for drainage of hematomas and two intracranial monitor placements. There were no cases of spinal cord injury and no procedures performed for spinal decompression or stabilization. Hospital stay varied between 1 and 143 days, with a mean of 6.6 days. 57 patients were eventually discharged, two were transferred to another hospital, one required inpatient rehabilitation and two died.

Conclusions ATV related accidents result in significant injuries to children. A large percentage of these patients sustained a neurosurgical injury requiring hospitalization, surgery or rehabilitation. Further efforts must be made to increase the proper operation and safety of ATVs, including education to parents and children and stricter laws concerning their use.

## 5. PREDICTORS OF EARLY CLINICAL OUTCOME IN PEDIATRIC MINOR HEAD INJURY

*Jeffrey D. Atkinson, MD, FRCS(C); Debbie Friedman, PT; Jose L. Montes, MD, FACS; Jean-Pierre Farmer, MD, FRCS(C) (Montreal, PQ, Canada)*

Introduction Mild head injuries represent a significant volume of trauma seen in a pediatric emergency department. At our institution a predefined set of admission criteria has resulted in many mild head injuries being admitted for overnight observation, often in lieu of neuroimaging with CT. The vast majority of these children are discharged the following day without need for acute neurosurgical or medical intervention, though follow up is provided, when appropriate, for long term cognitive, developmental, and physical issues.

Methods We performed a retrospective review of all of the cases of admitted head injuries from April 2001 - April 2004. We identified head injuries classified mild or moderate from our traumatic injuries database and explored clinical and demographic factors affecting length of stay. Predictors of length of stay were evaluated using univariate and multivariate statistical analysis.

Results 18% of the 6,103 head injuries seen at the MCH ER were admitted to the hospital. 1,076 of these patients had injuries classified as mild or moderate with 80.4% being discharged within one day of their admission. Predictors of length of stay longer than one day included injury severity classification, emergency room GCS, MVA or assault as injury mechanism, ambulance transport to hospital, and multi-system injury.

Conclusions The majority of children observed in the hospital for mild head injuries will remain well without the need for acute medical or neurosurgical intervention. Evaluation of predictors of prolonged hospital stay may allow diagnostic and treatment algorithms designed to direct acute medical resources to children most at risk.

## 6. "MOVING TARGET" MRI FOR EVALUATION OF HEAD TRAUMA IN UNSEDATED CHILDREN: EXPERIMENTAL STUDIES USING LARGE ANIMAL MODELS

**Kenneth Shulman Award Candidate**

*Dimitrios Nikas, MD; Alex Mamourian, MD; Ann-Christine Duhaime, MD (Lebanon, NH)*

Introduction Because of concerns regarding sedation and radiation exposure from CT scans used to evaluate children with head injury, recent attention has focused on alternate techniques. We report our experience with immature swine models of various traumatic lesions using "Moving-Target" MRI techniques compared to CT scans.

Methods 1-month-old piglets were anesthetized and underwent placement of subarachnoid, subdural, or epidural hemorrhages using autologous blood. Subjects underwent "quick-brain" (fast spin-echo T2) MRI and "Moving-Target" techniques ("Propellor", GE) including T1, T2, and diffusion sequences. CT scans with 2-3 mm cuts were then performed, followed by autopsy localization and measurement of lesions.

Results Both MRI and CT were relatively insensitive in detecting subarachnoid blood. "Quick-brain" scans could identify some degree of mass effect, but could not discern blood products. "Moving-target" MRI provided improved anatomic resolution, and some of these sequence, particularly diffusion, identified mass lesions comparable to CT. "Moving-target" sequences take longer than "quick-brain" scans (minutes vs. 30 seconds) but allow for correction for movement. This animal model has the disadvantage of small brain size and small lesions, which may decrease its sensitivity compared to children.

Conclusions Newer MRI techniques hold promise for trauma screening in unsedated children, with the advantages of decreased radiation and bone artifact, and no need for sedation. Continued efforts to shorten scan time and improve resolution are ongoing, with the goal of clinical testing in pediatric patients.

## 7. THE VALUE OF LIMITING RADIOGRAPHIC EVALUATION FOR DETECTION OF PEDIATRIC SPINAL CORD INJURY

**Kenneth Shulman Award Candidate**

*Stephanie Greene, MD; Mark R. Proctor, MD; Eric J. Woodard, MD; Dennis L. Johnson, MD (Boston, MA)*

Introduction Spinal cord injury (SCI) is a relative rarity in the pediatric population. Its evaluation usually warrants obtaining x-ray films, CT scans, and MR images. Many of these studies yield little additional information, but expose the patient to significant radiation and cost.

Methods Pennsylvania Trauma Registry was queried for cervical SCIs in patients younger than age of 14 years between 1986 and 1998. 375 records at the six pediatric trauma centers in Pennsylvania were identified. A retrospective chart review was performed.

Results 145 records were excluded from the study for a diagnosis of cervical strain or absence of cervical spine injury. Of the 224 patients remaining, 64% had neurological deficits and an additional 23% had neck pain. In those patients with cervical SCIs who underwent an adequate lateral cervical spine x-ray study, the injury was identified by this film 88% of the time. 39% of these patients had head injuries. The cost of films that were not necessary for diagnosis in this cohort of patients was $418,373, or an average of $1,868 per patient.

Conclusions Cervical SCI is frequently associated with head injury in children. The lateral cervical spine x-ray film is highly predictive of an injury to the cervical spine, as is the presence of neurological deficit. A CT of the occiput-C2 region is necessary in intubated patients. An MRI is necessary for patients with symptoms or persistent neck pain. Limiting the radiographic studies obtained will result in a substantial cost savings.

## 8. CERVICAL SPINE CLEARANCE AFTER TRAUMA IN THE PEDIATRIC POPULATION

*Richard C. E. Anderson, MD (New York, NY); Kris W. Hansen, RN; Douglas L. Brockmeyer, MD (Salt Lake City, UT)*

Introduction Currently, no diagnostic standards exist for clearing the cervical spine in children after trauma. The purpose of this study was to determine if re-education and initiation of a new protocol based on the NEXUS criteria to clear the cervical spine could safely increase the number of cervical spines cleared by non-neurosurgical personnel.

Methods Data regarding cervical spine clearance in children (ages 0-18 years) after trauma activation at our institution from 2001-2004 were collected and reviewed. Radiographic and clinical methods of clearing the cervical spine, as well as the type and management of injuries, were determined for two periods: (1) 2001-2003, and (2) January 2004-present.

Results From 2001-2003, nearly 100% of 936 cervical spines were cleared by the neurosurgical service. Twenty-one ligamentous injuries and eight fractures were detected, with five patients requiring operative stabilization. Since January 2004, 117 of 181 (65%) cervical spines have been cleared by non-neurosurgical personnel. Five ligamentous injuries and one fracture have been identified, with one patient requiring operative stabilization. No late injuries have been detected in either time period.

Conclusions The protocols utilized have been effective in detecting cervical spine injuries in children after trauma, with the new protocol increasing the number of cervical spines cleared by non-neurosurgical personnel by greater than 60%. Re-education with establishment of protocols can safely facilitate clearance of the cervical spine after trauma by non-neurosurgical personnel.

## 9. MATURATION-DEPENDENT RESPONSE TO TRAUMATIC SUBDURAL HEMATOMA IN THE IMMATURE PORCINE BRAIN

*Susan R. Durham, MD; Richard Traystman, PhD (Portland, OR); Ann-Christine Duhaime, MD (Lebanon, NH)*

Introduction Animal models of maturation-dependent response to traumatic brain injury (TBI) have recently been developed. Despite differing mechanisms of injury, these models suggest that immaturity may confer relative neuroprotection from TBI. The present study investigates the response of the immature brain to an experimental subdural hematoma in animals of three different age groups.

Methods 15 piglets (five each of age 1-week, 1-month and 4-month) were included for study. A subdural hematoma, scaled to 10% of brain volume, was created via a right parietal burr hole. At seven days, animals were euthanized and brains H&E and TUNEL stained. Brain injury was determined using standard histological criteria such as meningeal inflammation, gliosis or infarction. TUNEL-positive cells per high power field were counted to quantitate cell death.

Results Meningeal inflammation as the only histologic indicator of brain injury was found in 5/5 1-week old, 3/5 1-month old and 1/5 4-month old animals. Subcortical gliosis was found in 0/5 1-week old and 1-month old and 2/5 4-month old animals. Ipsilateral hemorrhagic infarction was found in 0/5 1-week old, 2/5 1-month old and 3/5 4-month old animals. TUNEL staining demonstrated 0 cells/hpf in the 1-week old, 26 cells/hpf in the 1-month old and 75 cells/hpf in the 4-month old animals.

Conclusions This study demonstrates an important maturation-dependent response to a scaled subdural hematoma. Younger animals are less vulnerable to a scaled subdural hematoma than their older counterparts at one week post-injury. Further investigation into the specific cellular mechanisms that confer relative neuroprotection in younger animals is warranted.

## 10. C1-2 TRANSARTICULAR SCREW FIXATION: A REVIEW OF 74 PEDIATRIC PATIENTS FOR SURGICAL INDICATION, FUSION RATE, COMPLICATIONS, AND LESSONS LEARNED

*Wayne M. Gluf, MD; Douglas L. Brockmeyer, MD (Salt Lake City, UT)*

Introduction Instability of the atlantoaxial or craniocervical joint complex presents unique challenges in pediatric spine surgery. Placement of C1-2 transarticular screws is associated with high fusion rates and relatively low risk.

Methods A retrospective review of 74 consecutive patients (26 female: 48 male) 16 years of age and younger, in whom at least one C1-2 transarticular screw was placed was performed. A total of 138 transarticular screws were placed in 74 patients. Mean age at time of surgery was 9.0 years (range 1.7-16 years). Surgical indications were trauma in 26 patients, osodontoideum in 26 patients, and congenital anomaly in 22 patients. Forty-seven patients underwent atlantoaxial arthrodesis and 27 patients underwent occipital-cervical fusion. Ten patients had undergone a total of 17 posterior fusion attempts prior to referral to Primary Children's Medical Center.

# ORAL ABSTRACTS

Results 67 patients have been followed for at least three months after surgery. Fusion was achieved in all 67 patients (100%). Mean time to fusion was 7.0 months. Complications occurred in seven patients (10%). Most were minor, though two confirmed vertebral artery injuries were identified. Neither resulted in permanent neurologic injury. Other complications included infection in four patients, and one hardware failure requiring reoperation.

Conclusions C1-2 transarticular screw placement, when coupled with the appropriate atlantoaxial or craniocervical bone/graft construct, resulted in a 100% fusion rate in a large consecutive series of pediatric patients. The risks of C1-2 transarticular screw placement can be minimized in the pediatric patient population with careful patient selection and preoperative planning.

## 11. LONG TERM MAINTENANCE OF CERVICAL ALIGNMENT AFTER OCCIPITAL CERVICAL FUSION IN PEDIATRIC PATIENTS

*Richard C. E. Anderson, MD (New York, NY); Peter Kan, MD; Wayne M. Gluf, MD; Douglas L. Brockmeyer, MD (Salt Lake City, UT)*

Introduction Pediatric patients with atlantoaxial or occipitocervical instability frequently require surgical stabilization. However, the long-term consequences of atlantoaxial or occipitocervical fusion are unknown, particularly in children with a growing spine (i.e., less than 9 years old). The purpose of this study was to determine the long-term effects of atlantoaxial or occipitocervical fusion on growth and alignment of the cervical spine.

Methods A retrospective chart review was conducted for patients less than or equal to 6 years old (mean = 4.7 years; range 1.7 to 6.8 years) undergoing OCF (either C1-2 or occipital-C2 fusion) at our institution within the last 10 years. Immediate postoperative plain radiographs and CT scans were compared with the most recent plain and dynamic radiographs to assess changes in spinal growth and alignment.

Results Twenty-nine children met entry criteria for the study. The average length of follow-up was 21 months. Successful fusion was documented in all patients with plain films or CT scans. No evidence of juxtafusion subluxation, kyphosis, lordosis, osteophyte formation or long-term instability was seen. The overall growth and lordotic alignment of the cervical spine was maintained. Seven patients with follow-up greater than 40 months were analyzed separately. Results similar to the main group were seen.

Conclusions Early follow-up suggests no increased risk for spinal deformity in children less than or equal to 6 years old undergoing atlantoaxial or occipitocervical fusion. Longer follow-up with measurements of the spinal canal will be necessary to determine precisely how the pediatric spine grows and remodels after such procedures.

## 12. MICRODISCECTOMY VS. CONSERVATIVE MANAGEMENT OF PEDIATRIC DISC DISEASE: OUTCOMES IN THE MODERN ERA

*Kevin L. Stevenson, MD; Roger J. Hudgins, MD; William R. Boydston, MD, PhD; Andrew Reisner, MD; Cathy Frysh, PA-C (Atlanta, GA)*

Introduction Despite the fact that the literature contains several series of pediatric disc disease and its management, no series exists in which every patient has been evaluated and treated in the modern MRI and microsurgical era. This study was undertaken to evaluate outcomes in pediatric patients with disc disease in the modern era.

Methods 45 pediatric patients were treated for symptomatic disc disease between 1998 and 2003. A retrospective review of office and hospital records was conducted along with phone interviews for long-term outcome analysis.

Results Average age at presentation was 15.6 years. A precipitating event was noted in 60%. Back pain was a more common complaint than radiculopathy (95.6% vs. 73.3%) in both groups. 57.9% of surgical patients had documented evidence of a decline in school performance/attendance. 95% of surgical patients had complete resolution of their radiculopathy by postoperative day 14 with 85% reporting complete resolution of back pain. The surgical group returned to school by an average of 1.8 weeks. At long-term follow-up, no surgical patient complained of radiculopathy while 28.6% of the conservative management group had active radiculopathy. 12.5% of the surgical group experienced occasional back pain compared to 71.4% of the conservative management group. 100% of the surgical group had an excellent-good long-term outcome compared to 35.7% of the conservative management group.

Conclusions This study represents the first analysis of pediatric disc disease management in the modern MRI and microsurgical era. In carefully selected patients, microdiscectomy is safe and effective treatment and is superior to prolonged conservative management.

## 13. MULTILEVEL CERVICAL DISCONNECTION ANOMALY - INITIAL DESCRIPTION, EMBRYOGENESIS AND MANAGEMENT

**Kenneth Shulman Award Candidate**

*Paul Klimo, MD, MPH; Richard Anderson, MD; Doug Brockmeyer, MD (Salt Lake City, UT)*

Introduction A number of congenital spinal anomalies are unique to the cervical spine. Treatment is based on several factors, including the patient's anatomy and the extent of the spinal malformation. We present three cases of a multilevel anomaly in which the pedicles are incompetent, thus creating a disconnect between the anterior and posterior elements. This disconnection resulted in severe instability that required immediate reduction, fixation and decompression if neural structures were being compromised. This anomaly has not been previously described.

Methods The presentation, management and postoperative course of three children (ages 2, 3 and 15) with multi-level incomplete pedicles are discussed. All patients presented with myelopathy and two with severe kyphosis and ventral spinal cord compression. The patients with kyphosis required reduction followed by an anterior-posterior fixation whereas the patient without deformity underwent a posterior approach alone. All patients had improved neurologic function on follow-up. Based on the embryogenesis of the spine, we believe this anomaly arises as a result of failure of complete development of the neurocentral synchondrosis, which eventually gives rise to the pedicles.

Conclusions This represents the first description of a multilevel cervical anomaly in which there are maldeveloped or absent pedicles. The severe instability caused neurologic injury in all patients and kyphosis in two out of three. In general, the management principles include resection of the apex of the kyphosus and extensive stabilization, usually both anteriorly and posteriorly.

## 14. CT IMAGE SEGMENTATION AND 3-D RECONSTRUCTION FOR EVALUATION OF OCCIPITAL-CERVICAL INSTABILITY IN CHILDREN

*Samuel R. Browd, MD, PhD; Lindsey McAninch; Greg Jones, PhD; Douglas L. Brockmeyer, MD (Salt Lake City, UT)*

Introduction Occipital-cervical (O-C) instability is commonly seen in children with Down's Syndrome. Dynamic imaging techniques such as flexion/extension views of the cervical spine are currently used to assess stability. We have developed a CT based image rendering technique to assess the O-C joint complex for morphologic changes that predict instability.

Methods CT images of the O-C joint were obtained from 10 children with Down's Syndrome and 10 age-matched controls presenting for trauma evaluations. 1mm axial, contiguous sections were obtained and post-processed for image segmentation. Volumetric and linear measurements of the O-C joint complex were evaluated.

Results Image segmentation provided 3D visualization of the O-C joint. Congenital changes in the morphology of the O-C joint correlated with instability on flex-extension views.

Conclusions High resolution CT imaging combined with new 3D rendering techniques allows assessment of the O-C joint for morphologic changes that correlate with instability.

## 15. HIGH FREQUENCY RADIOSURGERY: SURGICAL ADJUNCT FOR LUMBOSACRAL LIPOMA RESECTION AND SPINAL CORD DETETHERING.

*Anders J. Cohen, DO; Steven J. Schneider, MD (New York, NY)*

Introduction High frequency radiosurgery has recently been introduced in to the discipline. The paucity of heat generated at the surgical site allows for the surgeon to work in direct proximity to delicate structures. A wide variety of electrodes provides more intraoperative versitility. We utilized this technology in an attempt to attain a more complete resection of lumbosacral lipoma with accompanying tethered cord.

Methods Over a five year period, 28 patients ranging in age from 6 months to 5 years were treated for clinical and/or radiographic evidence of tethered cord with accompanying intradural lipoma. Standard methods of lumbar laminoplasty were used to expose the lumbar thecal sac. Various Radiosurgical elecrodes were used to resect lipoma in proximity to nerve roots and conus. All procedures had intraoperative monitoring.

Results Radical resection was achieved in all procedures. Nine patients had gross total resections that were comfirmed by postoperative MRI. No new neurological deficits were recorded. Pathology confirmed the diagnosis of lipoma in all patients. To date, no evidence of retethering has been observed.

Conclusions High frequency radiosurgery can be a valuable adjunct in this venue where precision is mandatory. It greatly facilitated the dissection and removal of intradural lipomas. A significantly greater resection can be attained. This may result in a better outcome and reduce the incidence of future retethering.

## 16. CONSERVATIVE MANAGEMENT OF ASYMPTOMATIC SPINAL LIPOMAS OF THE CONUS

*Abhaya V. Kulkarni, MD, FRCS (Toronto, ON, Canada); Alain Pierre-Kahn; Michel Zerah (Paris, France)*

Introduction The natural history of spinal lipomas of the conus (SLC) has not been well-studied. Based on disappointing long-term results with early surgical management of asymptomatic children with SLC, we have followed a protocol of conservative management of these patients. The results are presented in this report.

Methods Since 1994, all asymptomatic children with SLC seen at Necker Enfants Malades Hospital were subject to a protocol of conservative management. The records of these patients were reviewed to determine the incidence and timing of neurological deterioration. This was compared to a previously published historical cohort of asymptomatic patients who had received early surgery at our institution.

Results Fifty-three asymptomatic children (35 girls,18 boys) with SLC were followed with conservative management. During a mean follow-up of 4.4 years (12 months to 9 years), 13 (25%) patients developed neurological deterioration. At nine years, the actuarial risk of deterioration, based on the Kaplan-Meier method, for the conservatively managed patients was 33% and for the surgically managed patients it was 46%. Using a Cox proportional hazards model, there was no significant difference in the risk of neurological deterioration between those patients who were managed conservatively and those who received early surgery.

Conclusions The incidence and pattern of neurological deterioration appeared to be very similar regardless of whether early surgery was performed. These results suggest that conservative management of asymptomatic patients is a reasonable option. A more definitive randomized study will be required to better clarify the relative efficacy of early surgery for SLC in asymptomatic patients.

## 17. THE NEED FOR A NEW THEORY OF LIPOMYELOMENINGOCELE FORMATION

*Timothy M. George, MD; Thomas J. Cummings, MD (Durham, NC)*

Introduction Current hypothesis on the formation of lipomyelomeningocele is based on the premise that during late primary neurulation, premature dysjunction of the neurectoderm from the surface ectoderm occurs allowing mesenchymal cells to invade into a closing neural tube. Using standard and developmental markers, we analyzed resected lipomatous tissues and demonstrate that they cannot be simply derived from incarcerated mesenchyme that defaults into fat.

Methods Immunohistochemical analysis using standard and novel markers of surgical specimens of resected lipomatous tissue after lipomyelomeningocele repair was reviewed.

Results Standard immunohistochemistry revealed that tissue and cell types are present, such as adipose, skeletal muscle, smooth muscle, glia, fibroblast, and blood vessels in the resected lipomatous tissue, must have been derived from several embryologic origins. Novel developmental markers revealed that tissue indicative of primitive caudal cell mass tissues.

Conclusions Modern embryological data along with the results of immunohistochemistry of resected lipomatous tissue during lipomyelomeningocele repair argues for a new theory on the pathogenesis of these lesions. Clearly, mesenchymal incarceration leading to adipose tissue by default does not explain the multiple tissues and cell types seen in these lesions. Several possibilities will be discussed.

## 18. SUPRA-PLACODE SPINAL CORD TRANSECTION FOR PARAPLEGIC PATIENTS WITH MYELODYSPLASIA AND REPETITIVE SYMPTOMATIC TETHERED SPINAL CORD

*Elizabeth C. Tyler-Kabara, MD, PhD; R. S. Tubbs, PhD, PA-C; John C. Wellons III, MD; Jeffrey P. Blount, MD; W. Jerry Oakes, MD, (Birmingham, AL)*

Introduction The authors describe the technique of transecting the spinal cord in children born with myelomeningocele who have undergone multiple detherings and are functionally paraplegic.

Methods This technique involves identifying the neural placode and sectioning the normal spinal cord just superior to this site.

Results No postoperative complications have been identified in 14 patients undergoing this procedure over an 11 year time period. No patient at last follow up was found to have symptoms referable to a tethered spinal cord.

Conclusions The advantage of this procedure is to excise the normally pia-coated cord which is unlikely to retether from the neural placode which is often covered with scar tissue and does not have a well formed pial surface hence predisposing it to frequent dorsal adhesions. We believe this technique is of benefit in a small selected group of myelodysplastic patients with repetitive tethering of the spinal cord and should be a part of the neurosurgeon's armamentarium. The selectivity of this procedure is stressed.

## 19. SPINAL CORD EPIDERMOIDS FOLLOWING FETAL SURGERY FOR MYELOMENINGOCELE: CLINICAL CORRELATIONS AND FOLLOW-UP

*Leslie N. Sutton, MD (Philadelphia, PA); Ian F. Pollack, MD (Pittsburgh, PA); Gerald Tuite, MD (St. Petersburg, FL); Arnold Menezes, MD (Iowa City, IA); Leland Albright, MD (Pittsburgh, PA)*

Introduction Epidermoid inclusion cysts have been reported to occur following fetal myelomeningocele closure. The factors leading to this phenomenon and the long term clinical implications of this are unknown.

Methods Between March 1998 and February 2003, 58 fetuses underwent early gestation closure of myelomeningocle at the Children's Hospital of Philadelphia. Of the 54 survivors, six have been identified as having epidermoid inclusion cysts (11%). All have undergone surgery to remove the epidermoid, at four centers.

Results The mean age at fetal surgery for these six patients was 23 weeks, and the mean age at delivery was 34 weeks, which was no different from the group as a whole. Estimated anatomic level of the lesion ranged from L2-L5. Of the six, four had an Alloderm dural graft, and two did not. All patients were noted to have intact lower extremity function to S1 at birth. The mean age at the time of diagnosis of the epidermoid was 1.3 years. Four patients had decrease in lower extremity function, and two were assymptomatic, with the lesion found on surveillance MRI. The mean age at followup is 3.8 years. One patient has had symptomatic recurrence of the epidermoid, and underwent reoperation at a time beyond the Collin's Law period of risk. Two have exceeded their Collin's Law period without recurrence, and three have not yet reached this point. All patients lost function as a result of the epidermoid and the surgery, but most have regained function with time.

Conclusions Epidermoid formation may occur following fetal surgery for myelomeningocele.

## 20. MYELOMENINGOCELES AND MECONIUM

*Josephine Wyatt-Ashmead, MD; Andrew Parent, MD; John Lancon, MD; Amanda Ellis,RN; James Bofill, MD; Steven Bigler, MD; Alexandra Ashmead (Jackson, MS)*

Introduction To check whether elective Cesarean sections of babies with myelomeningoceles are effective in avoiding factors that would destroy the splayed-open spinal cord elements in myelomeningoceles, we examined the placentas (diaries of the pregnancies) and the removed myelomeningocele sacs of babies undergoing myelomeningocele repair.

Methods Over a four and a half year period, 32 babies (17 boys/15 girls) were born with myelomeningoceles that were promptly repaired. 23 placentas (seventy-two percent) were sent for pathologic examination (grossly examined a minimum of 17 factors and selectively sampled a minimum of 14 areas for light microscopic examination). All 32 myelomeningocele sacs were sent for pathologic evaluation (grossly examined and sampled in toto for light microscopic examination).

Results Only three placentas showed an acute ascending amniotic fluid infection, but all 23 placentas showed meconium histiocytosis. Meconium was seen in all 32 myelomeningocele sacs.



Conclusions Elective Cesarean sections of babies with myelomeningoceles are somewhat effective in avoiding acute ascending amniotic fluid infections but are not effective in avoiding meconium passage. Babies with myelomeningoceles often have poor bowel control and, as early as 14 weeks gestation, probably pass meconium continually in utero ("meconium incontinence"). Caustic/toxic meconium destroys the vulnerable spinal cord elements in the myelomeningocele directly and indirectly through vasospasm. Thus, in utero repair of the myelomeningocele or, at least, amniotic fluid exchange is needed to avoid the destructive effects of meconium.

## 21. THE DIFFERENCE IN CLINICAL OUTCOME IN PATIENTS WITH TERMINAL MYELOCYSTOCELE WITH OR WITHOUT ABDOMINAL DEFECTS

*Hector E. James, MD (Jacksonville, FL)*

Introduction This is a clinical report of eight patients with terminal myelocystocele. Four with associated ventral wall defects and four without. The initial diagnosis, neuro imaging, surgery and follow-up is described.

Methods There were seven females and one male. Initial age at diagnosis ranged from prenatal (by imaging) to 14 years. Operative correction was performed from 6 weeks to 14 years of age. The four patients with associated abdominal wall defects (OEIS Complex - omphalocele, exstrophy of the bladder, imperforate anus, spinal defects), are significantly handicapped, two are wheelchair bound, two ambulate with prosthetic devices and all have sphincter incontinence. The four patients without abdominal defects are fully ambulatory, one with an ankle foot orthosis, one patient has normal sphincter function, the other three are on intermittent clean catheterization. No patient has hydrocephalus or the Chiari malformation. It is concluded that these two subsets have a different clinical course. Prenatal and postnatally diagnosed terminal myelocystocele counseling in reference to outcome, has to be directed by the presence or absence of abdominal wall defects.

Conclusions It is concluded that patients with terminal myelocystocele without abdominal wall defects have a more favorable neurological outcome when compared to those with ventral wall defects.

## 22. FALLING CSF SHUNT RATES FOR MYELOMENINGOCELE IN CANADA

*Patrick J. McDonald, MD, FRCS(C) (Winnipeg, MB, Canada); James M. Drake, MD, FRCS(C); Maria Lamberti-Pasculli, RN; James T. Rutka, MD, FRCS(C); Robin P. Humphreys, MD, FRCS(C); Peter B. Dirks, MD, FRCS(C) (Toronto, ON, Canada)*

Introduction Historically, up to 80% of infants born with a myelomeningocele (MMC) require CSF shunts to manage hydrocephalus. The incidence of MMC has declined in the past decade at our institutions and we hypothesize that the neurosurgical management of MMC patients also changed.

AIM: To determine if current MMC patients have the same CSF shunt insertion and Chiari decompression rates as in past decades.

Methods We reviewed our surgical database for patients with MMC over the time periods 1980-89, 1990-99, and 2000-02 and determined how many patients required CSF shunts and Chiari decompressions. All patients had MMC repair, shunt insertion, and clinical follow-up at either the Hospital for Sick Children or Winnipeg Children's Hospital. Follow-up ended in January 2004.

Results From 1980-89, out of 351 MMC's repaired, 269 (77%) had CSF shunts and 45 (13%) required Chiari decompression. From 1990-99, 160/255 (63%) MMC patients required shunts and 16/255 (6%) had a Chiari decompression. In 2000-02, 13/25 (52%) MMC patients had CSF shunts and 1/25 (4%) had Chiari decompressions.

Conclusions In the year 2004, a child born with a MMC is less likely to have either VP shunt inserted or a Chiari decompression than in the past. This may reflect either a change in the characteristics of the patient population, or in management philosophy. These new rates of shunt insertion and Chiari decompression may have important implications when considering the utility of in utero MMC repair as a means of lowering the historical rates of shunt and Chiari decompression.

## 23. FAMILIAL RELATIONSHIP BETWEEN CHIARI 0 AND CHIARI I

**Kenneth Shulman Award Candidate**

*Roham Moftakhar, MD (Madison, WI); Marcy C. Speer, MD (Durham, NC); R. Shane Tubbs, PhD; W. Jerry Oakes, MD (Birmingham, AL); Bermans J. Iskandar, MD (Madison, WI)*

Introduction Chiari-0 describes a pathophysiological process at the foramen magnum that causes syringomyelia, but without tonsillar ectopia. As with Chiari-I, decompressing the posterior fossa of patients with Chiari-0 results in resolution of the syrinx. In this report, we examine a possible genetic link between Chiari-0 and Chiari-I.

Methods Families were recruited for this study through a proband in whom Chiari-I with or without syringomyelia had been documented on MRI. Individuals with syndromic, traumatic, or tumor-related causes were excluded. All medical records and MR images were reviewed.

Results We identified five pedigrees in which first-degree relatives of the Chiari-I patient (proband) had syringomyelia without tonsillar herniation (Chiari-0). The clinical presentation of three, and the syrinx location in four of the Chiari-0 subjects were almost identical to those of their respective Chiari-I relative. Improvement after posterior fossa decompression occurred in both Chiari-0 patients and three of the four Chiari-I patients who underwent surgery.

Conclusions Familial clustering of Chiari-0 and Chiari-I is demonstrated in five pedigrees. Familial clustering can be due to environmental causes or chance, although known "environmental" causes for Chiari-I were excluded, and each condition is uncommon enough that co-occurrence within families would be rare. We demonstrate that Chiari-0 and I share certain clinical and anatomical characteristics; they are associated with syringomyelia; and the syrinx responds to posterior fossa decompression. Our results suggest that Chiari-0 and I are related by a common pathophysiological mechanism, perhaps due to an underlying genetic basis, and that tonsillar herniation is not essential for the occurrence of a Chiari pathophysiology.

# ORAL ABSTRACTS

## 24. POSTERIOR CRANIAL FOSSA VOLUME IN PATIENTS WITH RICKETS: INSIGHTS INTO THE INCREASED OCCURRENCE OF CHIARI I MALFORMATION IN METABOLIC BONE DISEASE

*Elizabeth C. Tyler-Kabara, MD, PhD; R. S. Tubbs, PhD, PA-C; John C. Wellons III, MD; Jeffrey P. Blount, MD; W. Jerry Oakes, MD, (Birmingham, AL)*

Introduction Some have proposed that the calvarial thickening seen in patients with rickets results in an increased rate of Chiari I malformation in these patients. The current study measures the posterior fossa volume in children with rickets in order to verify previous case reports indicting a small posterior fossa as the etiology for an increased rate of Chiari I malformation in children with rickets.

Methods Patients were chosen using a computer database to search for individuals diagnosed with rickets. Nineteen patients were identified with this diagnosis. Seven patients were found from this cohort to have imaging of the head. Axial CT and MR images were then analyzed using the Cavalieri method to define posterior fossa volumes. These data were then compared to age-matched controls.

Results Mean volumes of the posterior fossa were significantly reduced in all patients compared with age-matched controls ($p < 0.0001$).

Conclusions We have found that the volume of the posterior fossa is significantly smaller in children with rickets versus age-matched controls. Further, 29% of our study group had an associated CIM. This data will hopefully aid in the further understanding of the pathophysiology of CIM in cases of metabolic bone disease.

## 25. ANTIBIOTIC-IMPREGNATED SHUNT CATHETERS DECREASE THE INCIDENCE OF SHUNT INFECTION IN THE TREATMENT OF HYDROCEPHALUS

**Hydrocephalus Award Candidate**

*Daniel M. Sciubba, MD; R. M. Stuart, BA; Matthew J. McGirt, MD; Graeme F. Woodworth, BS; Amer F. Samdani, MD; Benjamin Carson, MD; George I. Jallo, MD (Baltimore, MD)*

Introduction Most shunt infections occur within six months of shunt placement and chiefly result from perioperative colonization by skin flora. Antibiotic-impregnated shunt (AIS) systems have been designed to prevent such colonization. In this study, we evaluate incidence of shunt infection after introduction of an AIS system in a pediatric hydrocephalus population.

Methods We retrospectively reviewed all pediatric patients undergoing CSF shunt insertion at our institution over a three-year period. During 18 months prior to October 2002, CSF shunts included standard, non-impregnated shunt catheters. During the 18 months following October 2002, CSF shunts included antibiotic-impregnated shunt catheters. Patients were followed for six months after surgery, and all shunt-related complications, including infection, were evaluated. The independent association of antibiotic-impregnated shunt catheter use with subsequent shunt infection was assessed via multivariate proportional hazards regression analysis.

Results 147 pediatric patients underwent 325 shunting procedures. 181 (56%) shunts were placed with non-impregnated catheters prior to October 2002. 144 (44%) shunts were placed with antibiotic-impregnated shunt catheters after October 2002. Sixteen (9%) patients with non-impregnated catheters experienced shunt infection, whereas only three (2%) patients with antibiotic-impregnated catheters experienced shunt infection within the Six-month follow-up period, $p = 0.025$. Antibiotic-impregnated shunt catheters, adjusting for inter-cohort differences via multivariate analysis, were independently associated with a 3.5-fold decreased likelihood of shunt infection.

Conclusions The antibiotic-impregnated shunt catheter significantly reduced incidence of CSF shunt infection in children with hydrocephalus during the early post-operative period (less than six months). The AIS system used is an effective instrument to prevent perioperative colonization of CSF shunt components.

## 26. INTERNATIONAL INFANT HYDROCEPHALUS STUDY (IIHS): STUDY DESIGN AND PROSPECTS

*Shlomo Constantini, MD (Tel Aviv, Israel); Spyros Sgouros, MD (Birmingham, United Kingdom); Abhaya Kulkarni, MD (Toronto, ON, Canada)*

Introduction The International Study Group on Neuroendoscopy (ISGNE), and the ISPN, have recently defined an urgent need for prospective studies on Neuroendoscopy aiming at providing class I evidence.

Methods We have selected a group of infants under 2 years of age with obstructive hydrocephalus to be a target of a multi-center, prospective, randomized study on the yield of endoscopic third ventriculostomy versus conventional shunting (IIHS). We have decided to concentrate on long-term, neuro-behavioral results as our primary outcome measure.The paper will present the study-design, and update on the issues of organizing such a large scale international cooperation.

## 27. THE MANAGEMENT OF SHUNT INFECTION: A MULTICENTER PILOT STUDY

*John R. W. Kestle (Salt Lake City, UT); Hugh Garton (Ann Arbor, MI); William Whitehead (Indianapolis, IN); James Drake; Abhaya Kulkarni (Toronto, ON, Canada)*

Introduction Approximately 10% of cerebrospinal fluid (CSF) shunt operations result in infection and require removal/externalization of the shunt, antibiotics (in hospital), followed by insertion of a new shunt. In previous surveys, we identified substantial variation in the duration of antibiotic therapy (and length of hospital stay). The current multicenter pilot study was undertaken to evaluate variability in the management of shunt infection.

Methods Patients were entered if they had a culture proven CSF shunt infection. Details of their care and the incidence of culture proven reinfection were recorded.

Results Fifty-nine patients from 10 centers were followed for a mean of seven months. Reinfection occurred in 15 patients (25%). Of the 15 reinfections, there were 10 with the same organism and five with new organisms. Treatment time varied from three to 47 days with a mean of 17 days for those who later got reinfected and a mean of 14 days for those who did not. The initial management was shunt externalization in 14 patients, shunt removal and external ventricular drain insertion in 43 patients and antibiotics alone in one patient. The most common organism (staphylococcus epidermidis, 31 patients) had a reinfection rate of 32% and a mean treatment time of 12.4 days for those who had reinfection and 11.2 days for those who did not.

Conclusions Reinfection after treatment of CSF shunt infection is alarmingly common. Based on the data available the incidence of reinfection does not appear to be related to the duration of antibiotic therapy.

## 28. THE PERMEABLE PROXIMAL CATHETER PROJECT: A NOVEL APPROACH TO PREVENTING SHUNT OBSTRUCTION

**Kenneth Shulman Award Candidate**

*Joshua E. Medow, MD (Madison, WI)*

Introduction Shunt malfunction is a significant problem in patients with hydrocephalus. Each component of the shunt can contribute to shunt failure but the vast majority of problems result as a consequence of proximal catheter obstruction. This paper describes a novel catheter design, tested ex-vivo, that is porous rather than slotted and is permeable to most CSF components but not to prokaryotic and eukaryotic cells.

Methods A Cellulose Acetate (CA) filter with a pore size of 0.22 microns and a surface area of 1734.94mm2 was placed into a water bath that emptied into a burretrol drainage system set to siphon at lengths of 5,10,15,20,and 30cmH2O. The rate of drainage of the CA filter catheter was measured at each pressure level and was compared to drainage rates for a standard 15cm slotted ventriculostomy catheter.

Results

Pressure Head
1734.94mm2filter
5cmH2O
360ml/hr
10cmH2O
480ml/hr
15cmH2O
540ml/hr
20cmH2O
840ml/hr
30cmH2O
1440ml/hr

Conclusion By preventing cells from permeating the catheter wall it is thought that the rate of proximal catheter obstruction can be significantly limited. Our approach in using a CA porous membrane was to prove the feasibility of obtaining acceptable flow rates across a permeable membrane. Future materials need not involve CA but may be derived from other "inert" materials instead. The CA filter in our experiments provided for good flow but also had an increased potential for trapping debris. Although further in vivo testing is necessary, the design concepts presented in this paper may contribute to improving the way we prevent proximal catheter obstructions.

## 29. PROGRAMMABLE VERSUS FIXED-PRESSURE VALVES FOR THE TREATMENT OF HYDROCEPHALUS IN CHILDREN

*Chris Heller, MD; Mark D. Krieger, MD; David I. Sandberg, MD; Bryan C. Oh, MD; J. Gordon McComb, MD (Los Angeles, CA)*

Introduction Programmable shunt valves have been advocated for the treatment of hydrocephalus with the expectation of fewer operative revisions. We studied the efficacy of these valves in children, a group that traditionally poses unique challenges in the treatment of hydrocephalus.

Methods We retrospectively reviewed 197 children undergoing either insertion of a ventriculo-peritoneal, pleural, or atrial shunt or shunt revision involving valve replacement over an eighteen-month period. Ninety-nine children in the "Delta" group received Medtronic Delta valves with non-adjustable pressure settings. Ninety-eight children in the "Strata" group received Medtronic Strata programmable valves. Shunt survival, infections and valve adjustments were tabulated.

Results The "Delta" and "Strata" groups had similar rates of revision [15 of 99 (15%) and 18 of 98 (18%) respectively] and infection [5 of 99 (5%) and 8 of 98 (8%) respectively]. Five patients in the "Strata" group required pressure adjustments for symptoms of over or under drainage, but three of these patients subsequently required surgical revision. Three patients had their valve settings changed by MRI with severe symptoms including bradycardia and posturing. All recovered fully with reprogramming of their valves. We also noted increased metallic artifact on MRI with the programmable valves, which impaired imaging of the posterior fossa.

Conclusions Ninety-eight programmable valve placements were therapeutically efficacious in two patients, but caused serious problems after MRI in three patients and impaired MR imaging in others. We did not find a significant advantage in using programmable shunt valves to offset the higher cost, post-MRI reset problems, and effect on MR image quality.

## 30. CRANIOTOMY FOR FENESTRATION OF MULTILOCULATED HYDROCEPHALUS IN PEDIATRIC PATIENTS

*David I. Sandberg, MD; J. Gordon McComb; Mark D. Krieger (Los Angeles, CA)*

Introduction Our objective was to assess the treatment of progressive multiloculated hydrocephalus by craniotomy for microsurgical fenestration of cerebrospinal fluid (CSF) compartments in order to reduce the number of ventricular catheters.

Methods We studied 33 pediatric patients who underwent craniotomies for fenestration of progressive multiloculated hydrocephalus between 1989 and 2003. In 20 patients, hydrocephalus was attributed to intraventricular hemorrhage associated with prematurity. Twenty-three patients had prior central nervous system infections. Craniotomy was typically performed via a posterior parietal approach.

Communication between bilateral supratentorial and posterior fossa CSF compartments was achieved. Surgical and neurological outcomes were assessed.

Results Fenestration of loculated CSF spaces was successfully performed in all patients. No new neurological deficits were noted postoperatively. CSF infections within three months postoperatively occurred in four of 33 patients. Over a median follow-up period of 3.7 years (range 1.5 months to 8.7 years), 19 of 33 patients required additional fenestration procedures. The majority of patients (n=25) were successfully managed with only one ventricular catheter. Neurological status was extremely poor both pre-operatively and post-operatively. Twenty-eight of 33 patients were severely delayed and 4 were mildly delayed.

Conclusions Craniotomy for fenestration of loculated CSF compartments can effectively treat multiloculated hydrocephalus and can enable most patients to avoid multiple shunt catheters.

## 31. PHASE II TRIAL OF CONFORMAL RADIATION THERAPY FOR PEDIATRIC PATIENTS WITH CRANIOPHARYNGIOMA AND CORRELATION OF RADIATION DOSAGE WITH CHANGE IN COGNITIVE FUNCTION

*Thomas Merchant, DO, PhD; Erin Kiehna, BS; Larry Kun, MD; Raymond Mulhern, PhD; Cheng Hong Li, MD; Xiaoping Xiong, MD; Fredrick Boop, MD; Robert A. Sanford, MD (Memphis, TN)*

Introduction The best treatment for craniopharyngioma in children remains debatable, both surgical resection and limited surgery plus radiation result in approximately 85% cure. The debate centers on quality of life. The senior author reported (AANS 2002) a 10 point decrease in IQ in 40 children treated from 1985-1997 with standard radiotherapy.

Methods In a prospective study (July 1997-January 2003) 28 pediatric patients received conformal radiation therapy (CRT) with a 1 cm margin encompassing the solid tumor and cyst. The children were serially evaluated with neuropsychometric testing. They were divided according to extent of surgery; Group A: CRT plus extensive surgery with an intent for cure, Group B: limited surgery (optic nerve decompression or cyst drainage).

Results Multiple variate analysis revealed that cognitive outcome was adversely affected more in Group A (p=0.023); 2-3 surgical procedures (p=0.0002), age 7.7 years or younger(P=0.1), hydrocephalus present at diagnosis (p=0.38). Other negative factors included diabetes diagnosed before CRT, nonlateralized midline tumor, multiple shunt revisions, and multiple cyst aspirations.These results will be contrasted to the 40 children treated prior to 1997.

Conclusions CRT with a 1 cm clinical target volume results in tumor control equivalent to that achieved using conventional radiation therapy. Surgical morbidity significantly affects longitudinal IQ after CRT, and radiation dosage can be used to predict longitudinal IQ in pediatric patients treated for craniopharyngioma. Though conformal radiation therapy seems to be less harmful to the developing brain, loss of IQ points is unfortunately still a major problem. This study conclusively demonstrates the adverse effect of aggressive surgical procedures.

## 32. CONVECTION AND DIFFUSION DISTRIBUTED ANTI-GLIOMA MONOCLONAL ANTIBODY 8H9 IN THE BRAIN FOLLOWING INTERSTITIAL INFUSION

**Kenneth Shulman Award Candidate**

*Neal Luther; William J. Ryder; Nai-Kong Cheung, MD, PhD; Philip H. Gutin, MD; Mark M. Souweidane, MD (New York, NY)*

Introduction High-grade gliomas constitute 15% of primary pediatric CNS malignancies. Monoclonal antibody (MAb)-mediated immunotherapy has utility in cancer treatment. MAb 8H9 is reactive to over 85% of gliomas without cross-reactivity to normal brain. Immunotherapy of invasive gliomas relies on delivery that bypasses the BBB, achieving high local antibody concentration and distribution in tumor and normal parenchyma. We demonstrate that large volumes of distribution (Vd) of 8H9 can be achieved in the brain via interstitial infusion, a delivery mode utilizing bulk flow to enhance drug distribution and uniformity.

Methods Stereotactically-guided interstitial infusion of biotinylated 8H9 into the striatum was performed in 24 rats. Dose and volume of infusion were independently varied. Animals were sacrificed 1, 24, or 72 hours following infusion to determine 8H9 Vd. Brains were sectioned, reacted with streptavidin-peroxidase, and visualized after incubation in diamenobenzidine.

Results Increasing dose and volume of infusion both increased 8H9 Vd at one hour and 24 hours following infusion. Measurements of Vd at 24 hours were greater than those at one hour for all groups. Antibody was not detectable 72 hours following infusion. No rats experienced clinical neurotoxicity.

Conclusions Dose and volume of antibody infusion correlate with MAb Vd. The increasing 8H9 Vd with infusion volume at 1 hour coupled with the observation of larger Vd within groups 24 hours following infusion suggest antibody distribution in naïve brain is driven by convection and diffusion. The distributive properties and safety of 8H9 in brain parenchyma in this model support the potential utility of this MAb as a therapeutic conjugate.

## 33. PEDIATRIC PNETS: EFFECTS OF SURGICAL AND ADJUVANT THERAPY ON PATTERNS OF RECURRENCE AND PROGRESSION

*P. Ryan McGarry; J. Gordon McComb, MD; Ira Bowen; Mark D. Krieger, MD (Los Angeles, CA)*

Introduction The outcome of children with primitive neurectodermal tumors (PNET) is known to vary based on age, degree of surgical resection, and adjuvant therapy. The quantitative importance of these factors, however, has not been well characterized.

Methods 87 children treated for CNS PNET over 10 years at a single institution were retrospectively reviewed under an IRB approved-protocol. Patients were aged 30 months to 20 years (mean 6 years). 54 patients (64%) had gross total resection (GTR) whereas 33 patients (36%) had subtotal resection or biopsy only (STR). 56 patients (64%) received chemo- and radiation therapy, 20 patients (23%) received chemotherapy only, and two (2%) received radiation therapy only. Multivariate analysis was conducted examining degree of resection, age, adjuvant therapy in relation to progression free survival and overall survival.

Results Overall five-year survival was 80%. 35 patients (40%) had recurrent or progressive disease, with a mean time of 21 months to recurrence/progression (range 1-74 months). Degree of resection conferred a distinct survival advantage regardless of age and adjuvant therapy: 19 patients (35%) with GTR had a recurrence vs 16 patients (53%) with STR. Age was not seen to be an independent prognostic factor. Regardless of age and degree of resection, time to recurrence was only influenced by radiation therapy (XRT): children without XRT recurred at 9 months, vs 23 months for those without.

Conclusions Degree of surgical resection is the most important prognostic factor for survival in PNET. The time to recurrence cannot be reliably predicted, but radiation therapy seems to delay the time to recurrence, but did not affect the recurrence rate.

## 34. DIFFUSION-WEIGHTED MR IMAGING IN PEDIATRIC PATIENTS WITH SURGICALLY-TREATED INTRACRANIAL NEOPLASMS

**Kenneth Shulman Award Candidate**

*Justin S. Smith, MD, PhD; Henry Lin, BA; Katie Mayo, BA; Anuradha Banerjee, MD; Nalin Gupta, MD, PhD; Victor Perry, MD; Soonmee Cha, MD (San Francisco, CA)*

Introduction Diffusion-weighted imaging (DWI) measures the degree of water diffusion in vivo. Reduced diffusion can be seen in any brain injury that alters extracellular water motion. We have recently reported that DWI abnormality on immediate post-operative MRI was frequently observed following surgical resection of gliomas in adults. The purpose of this study was to investigate the occurrence of these abnormalities in a pediatric population.

Methods Thirty-three consecutive patients less than 18 years old with a newly diagnosed intracranial neoplasm underwent MR imaging, including DWI, before and within two days after surgical treatment.

Results Average patient age was 10.0 years (SD 5.7 years). Supratentorial and posterior fossa lesions were identified in 21 (66%) and 11 patients, respectively. Gross total resection was achieved in 26 cases (81%). None of the lesions demonstrated reduced diffusion on preoperative imaging. Postoperative imaging demonstrated 19 (59%) lesions with areas of reduced diffusion adjacent to the resection cavity with an average volume of 2.3 cubic cm (SD 2.0 cubic cm).

Conclusions DWI abnormality on immediate postoperative MRI is common following surgery for newly diagnosed intracranial neoplasms in pediatric patients. We have previously reported that similar regions of DWI abnormality in adults demonstrate contrast enhancement as early as postoperative day 15 and ultimately develop into areas of encephalomalacia. Focal contrast enhancement in the postoperative period can be confused with tumor recurrence. Our study suggests that in the pediatric population undergoing brain tumor surgery immediate postoperative DWI is useful in interpreting new areas of focal contrast enhancement on subsequent imaging.

## 35. DIFFERENTIATION OF PEDIATRIC CEREBRAL NEOPLASMS BY ADVANCED MAGNETIC RESONANCE SPECTROSCOPY

*Mark D. Krieger, MD; J. Gordon McComb, MD; Marvin D. Nelson, MD; Ashok Panigrahy, MD; Ignacio Gonzalez-Gomez, MD; Floyd Gilles, MD; Stefan Bluml, PhD (Los Angeles, CA)*

Introduction Treatment of pediatric CNS neoplasms is highly dependent on identifying tumor type and discerning tumor from other radiographic anomalies, including non-neoplastic postoperative changes. To overcome the limitations of current non-invasive imaging techniques, the present study utilizes novel magnetic resonance spectroscopy (MRS) techniques to elucidate identifying biochemical features of pediatric CNS neoplasms in vivo which may facilitate diagnosis and treatment.

Methods Under an IRB approved protocol, 42 children were identified with newly diagnosed, untreated brain tumors. Upon retrospective review, this series included 17 PNETs, eight pilocytic astrocytomas, six astrocytomas, six anaplastic astrocytomas, four ependymomas, three anaplastic ependymomas, three choroid plexus papillomas, and eight non-glial tumors. Using a novel technique, single voxel 1H MRS spectra of the tumors were acquired. This technique allowed absolute quantification of N-acetyl-aspartate (NAA), creatine (Cr), choline (Cho), myo-inositol (mI) and taurine (Tau). Controls consisted of an additional voxel in the occipital cortex of the same patients, and 32 normal age-matched patients studied on the same 1.5T GE clinical scanner.

Results Taurine was significantly higher in PNET tumor regions than in controls (3.94 iU ± 1.45 vs. 0.96iU ± 0.50, p<1e-7) or "Other Tumor" (0.47 ± 0.57, p<1e-10). Myoinositol was significantly higher in choroids plexus papillomas (>10iU), distinguishing these tumors from other tumors and controls. Creatine levels were significantly reduced in pilocytic astrocytoma regions (<0.5iU), distinguishing them from astrocytomas, other tumors, and controls.

Conclusions This study identifies biochemical constituents which uniquely identify pediatric CNS tumors and can be used as a non-invasive means of diagnosis and disease follow-up. Future work examines the correlation of levels of these constituents with disease activity.

## 36. PEDIATRIC POSTERIOR FOSSA TUMORS: PREOPERATIVE PREDICTORS OF CHRONIC HYDROCEPHALUS

**Hydrocephalus Award Candidate**

*Jay K. Riva-Cambrin, MD (Toronto, ON, Canada)*

Introduction Pediatric patients with posterior fossa tumors and pre-operative hydrocephalus are usually managed by tumor surgery followed by expectant care and a permanent CSF shunt or endoscopic third ventriculostomy (ETV) in those who develop hydrocephalus (approximately 30%). Recent literature suggests that pre-tumor surgery ETV may reduce the overall morbidity; however identifying the patients at highest risk would optimize this neurosurgical management while minimizing unnecessary procedures. We developed a preoperative clinical and radiological score to reliably predict which children with posterior fossa brain tumors will develop chronic hydrocephalus.

Methods A formal qualitative survey using an interview format of leading experts in the field and literature search provided a list of the most likely potential predictors of hydrocephalus in this population. Data from 343 patients (1988-2003) from HSC Toronto was analyzed by logistic regression to construct a prediction model, which was simplified into a prediction score representing preoperative risk of hydrocephalus.

Results Preoperative predictors of chronic hydrocephalus were age<2 (score=3), presence of papilledema (score=1), qualitative radiological hydrocephalus severity (score=2), presence of cerebral metastatic spread (score=3), and estimated tumor pathology by preoperative imaging (score=1). The model was significantly predictive with an area under the ROC curve of 79%. From a prediction score out of ten, those with a score higher than five are considered 'High Risk'.

Conclusions This clinical score will reliably predict a patient's individual risk of hydrocephalus as well as discriminate between 'high risk' patients and 'low risk' groups preoperatively. The 'high risk' cohort might well be targeted for pre-emptive CSF diversion strategies.

## 37. CUMULATIVE INCIDENCE OF RADIATION-INDUCED LESIONS OF MAGNETIC SUSCEPTIBILITY IN CHILDREN WITH MEDULLOBLASTOMAS

*Sean M. Lew, MD; Joseph N. Morgan, MD; Estee Psaty; Daniel R. Lefton, MD; Jeffrey Allen, MD; Rick Abbott, MD (New York, NY)*

Introduction The deleterious effects of cranial radiation on the developing brain are well-documented. However, as the sensitivity and sophistication of magnetic resonance imaging (MRI) increases, it is becoming clear that pediatric patients who have received cranial irradiation have a tendency for developing lesions demonstrating magnetic susceptibility within brain parenchyma. Much remains unknown about this phenomenon, including what these lesions represent, although there is reason to suspect that some (if not all) are cavernomas.

Methods A retrospective chart and film review was performed. The clinical and radiographic histories of pediatric patients previously treated with craniospinal radiation for medulloblastoma with MRI follow-up at our institution were reviewed.

Results Fifty-nine patients were identified with a mean age at radiation treatment of 7.7 years, and a mean follow-up time of 7.2 years. Eighteen patients (31%) developed 26 lesions, for a cumulative incidence of 6.1%/year. There was no significant correlation between age, gender, radiation dose or delivery method, with lesion development. Only one patient required surgical intervention for a symptomatic hemorrhagic lesion. Histology in this case was consistent with cavernoma.

Conclusions Intraparenchymal lesions of magnetic susceptibility are not uncommon following cranial radiation in children. Some (if not all) of these lesions are likely radiation-induced cavernomas. Most of these lesions follow a benign course and do not require intervention.

## 38. OCULOMOTOR ABNORMALITIES ARE COMMON AFTER RESECTION OF MIDLINE POSTERIOR FOSSA TUMORS

*Jeffrey G. Ojemann, MD; James O. Phillips, PhD; Richard G. Ellenbogen, MD; Anthony M. Avellino, MD; Avery H. Weiss, MD (Seattle, WA)*

Introduction Resection of midline posterior fossa tumors is a common pediatric neurosurgical procedure. Although deficits associated with such surgery are increasingly discussed (as with the 'posterior fossa syndrome'), the incidence of dysfunction from injury to medial cerebellar structures is unknown. This study reviews the post-operative oculomotor and vestibulo-ocular findings in these patients.

Methods Fifteen patients with midline cerebellar tumors (medulloblastoma, astrocytoma, and ependymoma; mean age 10y) were studied following surgery involving the vermis. Patients underwent quantitative eye movement recordings using binocular video-oculography to evaluate gaze holding and conjugate eye movements (saccades, smooth pursuits, full field optokinetic nystagmus).

Results All 15 (100%) had abnormalities of gaze holding or some aspect of conjugate eye movement. Deficits in gaze holding in the dark were always seen, with a quick loss of fixation often not apparent in the light. Disrupted saccades with either nystagmus or missing targets were seen. Dysmetric saccades included hypermetric saccades, with overshooting of targets. Targets were eventually approximated by repeated, overshooting, saccadic attempts. Hypometric saccades that undershoot the target were also seen. These various oculomotor deficits would be expected to lead to difficulty reading and complaints of blurry vision when viewing motion.

Conclusions Patients display a wide range of oculomotor and vestibulo-ocular deficits following resection of posterior fossa tumors, presumably due to injury to vestibulo-cerebellar structures. These deficits are not readily evident on bedside testing, or routine visual examination, and are likely to have impact on routine school and later life activities. Oculomotor testing is now part of our routine post-operative clinical evaluation.

## 39. SUPRACILIARY APPROACH FOR ANTERIOR CRANIAL FOSSA LESIONS IN CHILDREN

George I. Jallo, MD (Baltimore, MD); Lazlo Bognar, MD (Budapest, Hungary)

Introduction There are many surgical approaches for lesions situated within the anterior cranial fossa and/or suprasellar region. The frontolateral keyhole craniotomy is a minimally invasive approach for these lesions in children.

Methods We report a series of 31 children, that were operated upon at our institutions between 1998 to 2004, using this approach. The children ranged in age from 6 to 12 years (mean, 9.2 yrs). The duration of follow-up ranged from .5 to 6.0 years (mean, 2.6 yrs). All the children underwent a unilateral supraciliary incision and a keyhole craniotomy. The lesions were located in the suprasellar or anterior cranial fossa. The histology consisted of craniopharyngioma, optic gliomas, hypothalamic hamartomas and arachnoid cysts. The operative corridor was adequate for all cases except one for which a traditional craniotomy was performed. There were no untoward complications associated with the approach. There was only one infection which required reoperation and debridement.

Conclusions Our study supports the utilization of this approach for certain lesions. There is no increased morbidity as compared to conventional craniotomies in children.

## 40. USE OF LUMBAR SHUNT IN MANAGEMENT OF PATIENTS WITH SLIT VENTRICLES AND RECURRENT VENTRICULAR SHUNT MALFUNCTION

*Sandeep Sood, MD; Tiffany Powell, BS; Ryan Barrett, DO (Detroit, MI)*

Introduction Chronically shunted patients can often present with acute deterioration and persistent small ventricles despite shunt malfunction. Lumboperitoneal shunts (LPS) have been utilized in this population with some success. We address the long term outcomes in this study.

Methods Thirty-three patients who presented with slit ventricles and recurrent cluster malfunctions were converted to a LPS at mean age of 12 years. Initial ventriculoperitoneal shunt (VPS) was placed at a mean age of 16.5 months. Ten patients with obstructive hydrocephalus had an endoscopic third ventriculostomy, while four with an isolated ventricle who had failed endoscopic fenestration required a ventricular shunt in addition to the LPS. The number of LPS malfunctions and infections during follow-up were compared to the same for VPS over the same number of months prior to LPS conversion.

Results Twenty-six of the 33 patients were successfully converted to a LPS and data from 24 was available for analysis. There were 4.88 malfunctions and 0.50 infections for VPS and 1.67 malfunctions and 0.63 infections for LPS during a mean follow up of 17 months. There was a statistically significant ($p<0.000$) reduction in the rate of malfunction after conversion to LPS, whereas no statistical difference in the number of shunt infections ($p = .601$) was observed. No one presented acutely following malfunction of a LPS and none had symptoms suggesting development of a Chiari Malformation.

Conclusions Conversion to LPS is a safe and effective treatment option in the patients prone to rapid decompensation and frequent ventricular shunt malfunctions secondary to small slit-like ventricles.

## 41. DIAGNOSIS AND MANAGEMENT OF PEDIATRIC PSEUDOTUMOR CEREBRI

*Frederick A. Boop, MD, FACS; Robert A. Sanford, MD; Stephanie Einhaus, MD, DMSc; Michael Muhlbauer, MD (Memphis, TN)*

Introduction Recent data shows an alarming rise in obesity in children. Pseudotumor cerebri, an associated complication, has shown a parallel increase in incidence. This retrospective review demonstrates the relevant features of pseudotumor cerebri in a pediatric population, reviews our approach to the disease, and reviews available treatment strategies.

Methods A retrospective chart review was performed on 25 patients who presented to the pediatric neurosurgery service at LeBonheur Children's Medical Center from 1999 to July 2004.

Results Of the 25 patients, the mean age at presentation was 10.9 years. There were 3.3 times more females diagnosed. Obesity was present in 82% of females and 14% of males. Secondary etiologies included unilateral transverse sinus thrombosis in three, occult malignancy in two, trauma in two, secondary to medications in three, and idiopathic in the remainder. The most common presenting symptom was headache. A formal ophthalmological examination revealed papilledema in 100% and decreased visual acuity in 39% of the patients. Each individual underwent a lumbar puncture, computed tomography imaging, and magnetic resonance imaging including venography. Medical management was pursued initially in all patients. Two children initially underwent optic nerve sheath fenestration, both with subsequent deterioration in vision. Twenty one percent of children ultimately required a permanent CSF shunt.

Conclusions Pseudotumor cerebri in childhood is being diagnosed with increasing frequency. Obesity, sinus thrombosis, medication side-effects and other etiologies must be ruled out. When properly managed, only a small percentage of children presenting with pseudotumor cerebri will require shunting.

## 42. GENETIC INFLUENCES DRIVING THE CLOSURE OF THE CEREBRAL AQUEDUCT IN CONGENITAL HYDROCEPHALUS

Hydrocephalus Award Candidate

*Janet M. Miller, PhD; Gary S. Krause, MD; Steven D. Ham, DO; James P. McAllister II, PhD (Detroit, MI)*

Introduction To elucidate the pathogenesis of congenital hydrocephalus, we identified specific genetic components influencing closure of the cerebral aqueduct in the H-Tx rat.

Methods Midbrain regions were microdissected from five hydrocephalic and five control animals at 5 days of age. After RNA extraction, cDNA was subjected to PCR techniques, labeled and hybridized (one brain per array) to the Rat 230A oligonucleotide array from Affymetrix. Hybridization intensity for each array was measured using a confocal scanner, and results were normalized and reported as fold change differences. Raw expression data were subjected to a normal t-test as well as the Bayesian t-test method, a t-test that helps control for variations resulting from small sample size, and only those transcripts passing both the fold change and t-test cutoffs were examined further.

Results Forty-seven transcripts passed significance for both t-tests and a fold change cut-off of 1.5. Some of these altered genes correlated with earlier studies of hydrocephalus. For example, animals deficient in Nuclear Factor 1 fail to develop a corpus callosum and demonstrate ventriculomegaly, and this gene was down-regulated 1.58 fold in the H-Tx midbrain. Also, in adult human patients, cholecystokinin levels are reduced, and hydrocephalic H-Tx rats exhibit a 1.7 fold reduction in expression of this gene.

Conclusions These results suggest that gene alterations in the midbrain may cause aqueductal stenosis in this model. Identification of these genes provides direction for further studies that attempt to reduce the occurrence of this disorder in humans.

## 43. CAN THE SKULL DIPLOIC SPACE BE UTILIZED FOR ABSORPTION OF CEREBROSPINAL FLUID?

**Hydrocephalus Award Candidate**

*Jeffrey Pugh, MD; Keith Aronyk, MD (Edmonton, AB, Canada)*

Introduction Numerous sites have been utilized for the diversion and absorption of CSF, yet despite years of innovation, CSF shunt systems continue to have high complication rates. The calvarial diploë represents an alternative site for CSF diversion. The effectiveness of intraosseous infusion through calvarial diploë has never been explored. This research into a novel solution for the management of hydrocephalus could lead to a significant improvement in the treatment of this hydrodynamic disorder.

Methods An intraosseous infusion device was developed for accessing the calvarial diploë. Glucose and Technetium 99m were infused into mixed breed commercial pigs to study the absorption in an acute animal model. Systemic uptake was determined from serial samples obtained from an indwelling central venous catheter. The calvarium was removed at the conclusion of the study for histologic examination.

Results There was a rapid, significant rise in serum glucose measured from the femoral vein in all animals, from 66.25 mg/dl (95% CI 44.49 - 88.01) to 104.5 mg/dl (95% CI 101.0 - 108.0) following calvarial infusion of D50W. The Technetium 99m infusions confirm the rapid and reliable absorption of fluids through the calvarial diploë.

Conclusions Current management of hydrocephalus is not based on recreating normal CSF flow patterns from the brain to the dural venous system, but rather introduces new and complex hydrodynamic factors on an already complicated hydrodynamic disorder. Intraosseous infusion through the skull may represent a potential pathway to divert and absorb CSF, creating a shunt system that better restores a physiologic condition for CSF absorption.

## 44. ROLE OF SPECT SCANNING IN PEDIATRIC HYDROCEPHALUS

**Hydrocephalus Award Candidate**

*Deepak Agrawal; Pralay K. Nayak; C.S. Bal; Ashok K. Mahapatra (New Delhi, India)*

Introduction To study regional cerebral perfusion before and after ventriculo-peritoneal shunt placement in children with hydrocephalus, using 99mTc ECD SPECT.

Methods Seventeen consecutive children (less than 16 years) with hydrocephalus due to various causes, who were planned for ventriculo-peritoneal shunt, were included in this prospective study. Brain SPECT using 99mTc ECD was performed pre and postoperatively and changes in cerebral perfusion were compared with the change in ventricular size (assessed using the Evan's ratio).

Observation There were 11 male and six females with a mean age of 12 years. Eight children were less than 2 years of age and the mean duration of symptoms were six months. The cause of hydrocephalus was congenital in ten, secondary to tumor in five and as sequelae of infection in two children. Fourteen children (82%) showed improvement in cerebral perfusion following the shunt. Of these, 12 also had a concomitant decrease in ventricular size postoperatively.

Results Age greater than 2 years, duration of symptoms less than six months, a decrease in the ventricular size post shunt, and tumor associated hydrocephalus were independent predictors of improvement of cerebral perfusion following shunting.

Conclusions SPECT can prove to be a valuable tool for objective assessment of improvement in cerebral perfusion, in children with hydrocephalus secondary to various etiologies, following surgical or medical interventions.

## 45. COMPUTED TOMOGRAPHY BASED VENTRICULAR VOLUME MEASUREMENT IN RADIOGRAPHICALLY OCCULT SHUNT MALFUNCTION

*Prithvi Narayan, MD; Avi Mazumdar, MD; Dennis Rivet, MD; Jeffrey R. Leonard, MD; Tae Sung Park, MD; Ben Lee, MD; Matthew D. Smyth, MD (St. Louis, MO)*

Introduction Routine imaging studies may not support the diagnosis of a shunt malfunction. The aim of this study is to determine the usefulness of measuring supratentorial computed tomography (CT)-based ventricular volumes in children with radiographically occult, documented shunt malfunctions.

Methods A retrospective review over four years of all children who underwent shunt revisions was performed. Patients with a documented shunt malfunction and whose CT radiology report assessed no interval change were included (n = 7). Patients were excluded if there was an obvious increase in size of the ventricles, if the scans were of poor quality, if the shunt was infected or if there were mass lesions. The volume calculation software was Voxar 3DTM by Voxar Inc. (Boston, MA). Phantom balloon measurements were performed to validate the software. Two observers were blinded to the clinical data. The inter- and intra-observer reliabilities were assessed through intraclass correlation coefficient.

Results The phantom measurement had a mean error of -4.95%. The mean change in ventricular volume ranged from -2.3% to +29.1%. The inter- and intra-observer reliability was 0.93 and 0.87 respectively. The ventricular volume increased in five patients. Two patients with unchanged ventricular volumes had slit ventricles secondary to over-shunting, which improved with increasing the valve pressures.

Conclusions This is a rapid and objective method to assess supratentorial ventricular volume that can demonstrate an increase in ventricular size in otherwise radiographically occult shunt malfunction.

## 46. CHEMICAL ANALYSIS OF FLUID OBTAINED FROM INTRACRANIAL ARACHNOID CYSTS IN PEDIATRIC PATIENTS

*David I. Sandberg, MD; J. Gordon McComb, MD; Mark D. Krieger, MD (Los Angeles, CA)*

Introduction The chemical composition of intracranial arachnoid cyst fluid was analyzed to gain greater understanding about potential causes of cyst growth.

Methods We studied 54 pediatric patients who underwent craniotomies for arachnoid cyst fenestration between January 1994, and June 2003. Cyst fluid analysis was performed, and results were compared with expected values for cerebrospinal fluid (CSF).



Results Median values for arachnoid cyst fluid reached statistically significant differences when compared to expected CSF values for protein (median 37.0 mg/dl, mean 178.2 mg/dl, expected value 25.6 mg/dl, p=0.002), potassium (median 2.60 meq/L, expected value 2.88 meq/L, p = 0.004), and osmolality (median 284 mOsm/kg, expected value 287.2 mOsm/Kg, p=0.001). Median values for arachnoid cyst fluid were not significantly different from expected CSF values for sodium (median 140 meq/L, expected value 143.3 meq/L, p=0.054) or chloride (median 122 meq/l, expected value 120.3 meq/L, p = 0.268). Median glucose was 51 mg/dl. Median cyst fluid white blood cell (wbc) count was 1 per cubic mm, and median red blood cell (rbc) count was 1.5 per cubic mm. All gram stains and cultures were negative. No correlations were found between arachnoid cyst fluid protein level and elevated rbc count, patient age, or subsequent requirement of a shunting procedure. Elevated arachnoid cyst fluid rbc count also was not associated with subsequent need for shunting.

Conclusions Arachnoid cyst fluid has a chemical composition similar to that of CSF, but some arachnoid cysts have elevated protein levels. We hypothesize that elevated protein content may contribute to arachnoid cyst expansion in some patients.

## 47. ELEVATION OF CRABP-I IN THE CEREBROSPINAL FLUID OF MOYAMOYA DISEASE PATIENTS

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Introduction The etiology of moyamoya disease (MMD) remains obscure. This study was undertaken to identify specific proteins associated with the pathogenesis of MMD.

Methods We studied cerebrospinal fluid (CSF) from 20 patients with angiography confirmed MMD (4 boys and 16 girls, age range 3-13 years, mean 7.5 years) and four control patients with cerebral palsy, who underwent selective dorsal rhizotomy (two boys and two girls, age range 5-10 years, mean 7.3 years). CSF proteins were analyzed by two-dimensional polyacrylamide gel electrophoresis and protein identification was performed by Matrix-assisted laser desorption/ionization-time of flight mass spectrometry. The presence of specific CSF protein in patients with MMD was confirmed by Western blotting. In addition, cerebral CSF was also tested in seven patients who had other brain diseases but no MMD (two boys and five females, age range 1-12 years, mean 6.9 years).

Results We identified one polypeptide spot (Mr of 13-15 kDa and pI of 5-5.5) that was differentially expressed in the CSF samples of MMD patients (mean OD intensity; 0.36±0.24, range; 0.05-0.92) and control spinal CSF samples (mean; 0.03±0.04, range; 0-0.08, p=0.002). This polypeptide was identified as cellular retinoic acid binding protein (CRABP)-I. High levels of expression of CRABP-I in the CSF from 17 MMD children were confirmed by western blotting.

Conclusions The analysis of the CSF of MMD patients reveals high CRABP-I expression. The present study suggests that the elevation of CRABP-I in CSF may be a candidate for pathogenesis of MMD.

## 48. PEDIATRIC INTRACRANIAL ANEURYSMS: DURABILITY AND TREATMENT FOLLOWING MICROSURGICAL AND ENDOVASCULAR MANAGEMENT

**Kenneth Shulman Award Candidate**

*Nader Sanai, MD; Alfredo Quinones-Hinojosa, MD; Nalin M. Gupta, MD; Charles B. Wilson, MD; Christopher F. Dowd, MD; Victor L. Perry, MD; Michael L. Lawton, MD (San Francisco, CA)*

Introduction Intracranial arterial aneurysms in children are rare (1-2% of all cases), and their outcome after treatment is poorly described. We review the UCSF experience in patients treated from 1977 to 2003, focusing upon treatment durability.

Methods We identified 32 pediatric patients with 43 aneurysms treated, ages 2 months to 18 years (mean 11.7 years) and male:female ratio 14:18. Inpatient, clinic, and computer records were reviewed. Patients were followed up in clinic and by telephone interview. Mean follow-up was 5.67 years (range: 1 month-18.0 years).

Results Seven patients presented with subarachnoid hemorrhage (one with Hunt-Hess Grade I, four, Grade II, one Grade III and one Grade IV). Aneurysm locations included: internal carotid artery (N=13), middle cerebral artery (N=11), and basilar artery (N=6). Seventeen patients had giant aneurysms (>2.5cm). Thirteen were treated surgically, 16 endovascularly, and three patients were managed with observation. Two patients demonstrated spontaneous thrombosis of their aneurysms, but these subsequently recanalized and were treated with coiling. No patients died from treatment and two surgical patients developed new, permanent neurological deficits. In three patients, endovascular therapy resulted in incomplete obliteration. Three aneurysms recurred following endovascular treatment. In all but one case, surgery resulted in complete aneurysm obliteration and in no instances did a surgically treated aneurysm recur.

Conclusions Surgery and endovascular therapy can safely treat pediatric aneurysms. In this study, endovascular intervention demonstrated slightly higher rates of incomplete treatment and aneurysm recurrence. Considering the long life expectancy for this population, careful patient selection is needed, despite parent bias towards non-operative approaches.

## 49. MICROSURGICAL TREATMENT OF PEDIATRIC ARTERIOVENOUS MALFORMATIONS: RECENT UCSF EXPERIENCE

**Kenneth Shulman Award Candidate**

*Rene O. Sanchez-Mejia, MD (San Francisco, CA); Sravana Chennupati, AB, MS (Berkeley, CA); Nalin Gupta, MD, PhD; Victor Perry, MD; Michael W. McDermott, MD; Michael T. Lawton, MD (San Francisco, CA)*

Introduction AVMs have an incidence of 1/1000. Pediatric patients account for 12-18%. We evaluate our experience with pediatric intracranial arteriovenous malformations.

Methods A retrospective chart review of 38 consecutive pediatric patients who underwent microsurgical treatment of AVMs at UCSF between 1997-2003 was performed. Clinical presentation and outcome were evaluated with respect to radiographic cure, neurological examination, and Glasgow Outcome Scale.

Results Thirty-eight patients with a mean and median age of 13.3 ± 5.3 and 14 years, respectively, underwent microsurgical treatment between 1997-2003. Twenty-seven (71%) patients presented with AVM rupture. Using the modified Spetzler-Martin AVM scale our series consisted of four (10.5%) grade I, 19 (50.0%) II, four (10.5%) III -, one (2.6%) III, 5 (13.2%) III+, five (13.2%) IV, and no V. The most common symptom was headache, followed by seizures, nausea, and decreased level of consciousness. The pre- and post-operative GOS were 4.47 ± 0.95 and 4.78 ± 0.9, respectively. 90% of patients had improved or stable neurological function. Complete radiological cure was achieved with one operation in 36 (94.7%) of patients. Two patients with residual disease had complete radiological cure after postoperative stereotactic radiosurgery. There were no deaths in our series. Mean follow-up was 13.53 months. Frontal (36.8%) AVMs were the most common followed by temporal (26.4%) and cerebellar (18.4%). Illustrative cases for AVMs in different anatomical locations are presented.

Conclusions We present our experience with pediatric AVMs which is extensive. As we demonstrate here favorable outcomes can be obtained in all pediatric patients with AVMs, including grade III+ and IV.

## 50. DELAYED REPAIR OF SCAPHOCEPHALY: SIGNIFICANCE OF INTRACRANIAL PRESSURE

*Robert F. Keating, MD; Jonathan Martin, MD; Michael Boyajian, MD; Jeffery Posnick, DMD, MD; Derek Bruce, MD (Washington, DC)*

Introduction Despite previous reports that up to 8% of children with scaphocephaly may manifest increased intracranial pressure, few clinicians today observe intracranial hypertension for single-suture craniosynostosis. Clinical experience with older scaphocephaly patients at our institution, demonstrated a significant number of individuals manifesting increased intracranial pressure, confirmed by intraoperative measurements.

Methods Over a seven year period, 73 patients underwent scaphocephaly surgery. Fourteen patients (11 males/3 females) presented after 15 months of age (16m-96m, X~39.7m). None were syndromic nor had hydrocephalus. Patients were evaluated clinically for elevated ICP, papilledema, and CT changes.

Results 7/14 patients manifested ICP greater than 20 cm H2O, 4/14 had an ICP 15-20 cm and 3/14 had ICP less than 15 cm measured at the outset of craniofacial reconstruction. Papilledema was seen in 2/7 patients with an ICP greater than 20 cm and not in the other groups, whereas 3/7 patients with ICP greater than 20 cm were symptomatic and 3/7 had CT evidence for elevated pressure All patients had normalization of their ICP after calvarial vault reconfiguration and there was no postop morbidity / mortality. The average blood loss was 325 cc and the LOS was 3.8 days.

Conclusions Delayed repair of scaphocephaly in the older patient may be safely accomplished with minimal morbidity but must keep in mind the distinct possibility of elevated ICP, even in the patient with a paucity of clinical findings. Recognition and treatment of elevated intracranial pressure is paramount in offering a safe and effective craniofacial reconstruction in the older patient with scaphocephaly.

## 51. DEVELOPMENTAL DELAYS IN CHILDREN WITH DEFORMATIONAL PLAGIOCEPHALY: AN UPDATED REPORT

*Jayesh Panchal, MD, FRCS; Robin Gurwitch; Shaurin Patel; Paul Francel; John Honeycutt (Oklahoma City, OK)*

Introduction Over the last few increasing number of studies have demonstrated that children with deformational plagiocephaly demonstrate developmental delays. Previous studies have either had small numbers or did not include consecutive patients creating a selection bias. Purpose: The objective of the study was to determine whether children deformational plagiocephaly (DP) demonstrated motor and psychomotor delays when compared to a typical population.

Methods This was a prospective study, which involved 117 consecutive subjects with (mean age= 7 months). Each child was assessed using Bayley scales for motor and psychomotor development at the time of instituting molding helmet therapy. The distribution of the scores was divided into four groups: accelerated, normal, mild delay and significant delay. The distributions of the motor development index (MDI) and psychomotor developmental index (PDI) were then compared to a "typical" age matched population using chi squared goodness of fit test

Results The distribution of the MDI scores was 0 in the accelerated group, 90.6 in the normal group, 6.84 in the mildly delayed group and 2.56 in the severely delayed group as compared to 16.5, 68.7, 12.5 and 2.3 respectively. This difference was statistically significant ($p<0.001$). Similarly, the PDI was 0 in the accelerated group, 72.1 in the normal group, 17.24 in the mildly delayed group and 10.34 in the severely delayed group as compared to 14.8, 72.6, 11.1 and 1.6 respectively. This difference was statistically significant ($p<0.001$).

Conclusion The present study once again indicates that subjects with deformational plagiocephaly demonstrate delays in both motor and psychomotor development scales.

## 52. CORRELATION OF HEAD SHAPE VS. CEPHALIC INDEX FOR MEASURING OUTCOMES FOR SAGITTAL CRANIOSYNOSTOSIS

*Jayesh Panchal, MD, FRCS; Mike Dixon; Donna Tepper; Don Parker; Christie Burgin; John Honeycutt; Paul Francel (Oklahoma City, OK)*

Introduction Although normalization of head shape is the goal of craniosynostosis surgery, there is no consensus whether a cranial index (CI) or perception as measured on a scale is an appropriate tool to measure outcome. CI is a quantitative measurement but has been criticized because it measures only two dimensions of the skull. The aims of the present study were to determine whether 1) both CI and perceptual ranking are effective in discerning normal infants from those with sagittal craniosynostosis 2) CI and perceptual ranking of CT scans images were effective in discerning normal infants from those with sagittal craniosynostosis.



Methods A photographic assessment of 15 pre and postoperative head shapes and CT scans of infants who had undergone cranial vault remodeling for sagittal synostosis and normal age matched controls was performed by five lay observers and five board certified plastic and reconstructive surgeons. The photographs were ranked on a scale of 1 to 10 with 1 representing a "poor" head shape and 10 representing an "excellent" head shape. Box plots and AOV analysis were performed.

Results Both perceptual ranking and CI were effective in discerning infants who were normal from those with sagittal craniosynostosis ($p<0.001$). Similarly, perceptual ranking of CT scan images and CI were also effective in discerning between the normal infants and those with sagittal craniosynostosis ($p<0.001$).

Conclusion To conclude, CI can effectively be substituted instead of perceptual ranking of infants in measurement of outcome following surgery for correction sagittal craniosynostosis.

## 53. THE RISK OF CSF RHINORRHEA IN CRANIOFACIAL SURGERY

Kenneth Shulman Award Candidate

*Glenn Morrison, MD; Stephen Anthony Wolfe; John Ragheb (Miami, FL)*

Introduction There has been a great deal of variability in reporting the risk of a cerebral spinal fluid (CSF) leak following craniofacial surgery. This is a report on the results of 696 cases.

Methods Three hundred and seventy two of these procedures involved the correction of various craniosynostoses. Of the remaining 324 there were 82 cases of cranioplasty using a variety of autogenous bone graft sources and, in most cases, away from the cranial base. Thus there were 242 cases where there was clearly recognized transgression of the cranial base, and, therefore, a significant risk for a postoperative CSF leak: 64 cases of monobloc frontofacial advancements; 75 corrections of orbital dystopias, hyertelorism, hypotelorism; 88 cranial base tumors; and 15 with post-traumatic CSF rhinorrhea.

Results In the non-traumatic, elective, cases (227) there were 5 identified post-operative CSF leaks (2%). Three were stopped with lumbar drainage and two required re-operation (1 twice). Of the traumatic CSF leaks, five of the 15 continued with leakage postop and two stopped with further lumbar drainage and three required a second operation. Of these three, the preoperative CTs did show defects of the cranial base that were missed or underappreciated and not properly treated.

Conclusions The authors believe that if careful attention is paid to the cranial base at the time of craniofacial surgery (dural defects primarily sutured and reinforced with pericranium or fascia lata and the use of autogenous bone on the cranial base) the risk of a post-operative CSF rhinorrhea can be minimized to the order of 2%.

## 54. MICROSCOPIC APPROACH TO CRANOSYNOSTOSIS

*James E. Baumgartner, MD; John F. Teichgraeber, MD (Houston, TX)*

Introduction Over the last several decades, the treatment of craniosynostosis has evolved from limited strip craniectomies to selective cranial vault reconstruction. Recently Barrone and Jiminez have reported on minimally invasive, early endoscopic release of synostotic cranial sutures with postoperative helmet molding. Their published results have been encouraging. We describe an alternate minimally invasive, early microscopic approach followed by helmet therapy.

Methods From May 2001 to June 2004, the authors treated 20 patients with the microscopic technique. The patients average age a treatment was 12 weeks, with a range from 4 to 18 weeks. There were 13 cases of sagittal, three metopic, two unicoronal, one bicoronal and one lambdoidal synostosis. All patients underwent preoperative CT scanning of the craniofacial skeleton, pre- and post-operative anthropomeric measurements. Surgery was accomplished through small scalp incicisions using an operative microscope, and standard neurosurgical instruments. Peroperative transfusions were required in nine cases. Average hospital stay was 1.8 days.

Results The cephalic index was corrected to normal in 12 of 13 patients with sagittal synostosis. The 13th patient was noncompliant with helmet therapy. In sagittal synostosis patients three months of age or older, the results are superior to those obtained using open cranial vault reconstruction followed by helmet molding therapy treated at our institution. Eight of nine cases on non-sagittal synostosis were corrected to normal.

Conclusions Microscopic synostectomy results in excellent correction of cranial deformity in cases of sagittal synostosis. When compared to open synostectomy, hospitalization, operative time and blood loss are reduced.

## 55. DELAYED MULTISUTURAL SYNOSTOSIS: CLINICAL FEATURES AND SURGICAL CORRECTION.

*Khaled B. Aly, MD; Ashraf H. Abolnasr, MD; Ahmed Zaatar, MD; Ashraf ElSellawy, MD (Giza, Egypt)*

Introduction Delayed multisutural synostosis is common in our institute representing ~30% of the total volume of cases with craniosynostosis operated upon. This number is higher than reported in the literature and may be due to referral bias. In this work, the clinical features and management guidelines are discussed.

Methods 11 patients with delayed multisutural synostosis are presented. Mostly, the coronal and sagittal sutures were involved +/- the metopic suture. The main reason for referral was the presence of a vertex hump. The overall deformity was subtle. Ridging of the involved sutures was evident. Papilledema was present in all cases , and optic atrophy in one. The IQ was assessed in some patients and was reduced. Diffuse silver beaten appearance was evident on plain films in all cases. CT showed attenuation of the ventricular system and obliteration of the subarachnoid spaces.

Results The surgical correction depends on whether the metopic suture is involved or not. As the deformity is usually mild, the aim of surgery is mainly to expand the skull and remove the hump. Correction of the recession and backslanting of the forehead is second priority.

Conclusions Delayed multisutural synostosis is not uncommon in Egypt. Since the deformity is subtle, such cases may be missed or lately diagnosed. It has deleterious effects on the visual system and the patient IQ. Early diagnosis and correction is required.

## 56. VAGUS NERVE STIMULATION FOR INDUCED SPINAL CORD SEIZURES: INSIGHTS INTO SEIZURE CESSATION

Elizabeth C. Tyler-Kabara, MD, PhD; R. Shane Tubbs, PhD, PA-C; Jeffrey P. Blount, MD; John C. Wellons III, MD; W. Jerry Oakes, MD (Birmingham, AL)

Introduction Vagus nerve stimulation (VNS) is known to affect some seizures in both humans and animals. Although many theories abound concerning the mechanism for this action, the true etiology remains speculative. In order to potentially elucidate a pathway in which VNS aborts seizure activity, we have initiated seizures not in the cerebral cortex but in the spinal cord and then performed VNS.

Methods Ten pigs were placed in the lateral position and a laminectomy performed in the lumbar region. Topical penicillin, a known epileptogenic drug to the cortex and spinal cord, was next applied to the dorsal surface of the exposed cord. With the exception of two animals which were used as controls, once seizure activity was discernible via convulsion or increased electrical activity, the left vagus nerve was stimulated. Following multiple VNS and with seizure activity confirmed, the cord was transected in the midthoracic region and VNS again performed.

Results VNS resulted in cessation of spinal cord seizure activity in all (87.5%) but one experimented animal. Transection of the spinal cord superior to the site of seizure induction resulted in the ineffectiveness of VNS to cause cessation of seizure activity in all study animals.

Conclusions The effects of VNS on induced spinal cord seizures involves descending spinal pathways. To our knowledge, this experimentation is the first to demonstrate that spinal cord neuronal hyperactivity can be suppressed via stimulation of a cranial nerve. These data may aid in the development of alternative mechanisms for electrical stimulation for patients with medically intractable seizures.

## 57. EPILEPSY SURGERY IN YOUNG CHILDREN

*Andrea Douglas; Nicholas Post; Josianne LaJoie; Daniel Miles; Orrin Devinsky; Howard L. Weiner, MD (New York, NY)*

Introduction Few studies have addressed the use of invasive monitoring in young children with refractory partial epilepsy. We wanted to determine the safety and efficacy of a uniform surgery strategy by a single surgeon.

Methods Between 1998-2004, 93 consecutive children with refractory epilepsy underwent surgery at NYU. Nearly all had invasive grid, strip, and depth electrode placement. A standardized surgery protocol was utilized.

Results There were 51 females and 42 males (mean age 5.8). 47 had cortical dysplasia, 21 Tuberous Sclerosis, 9 tumor, 6 stroke, 4 Rasmussen's encephalitis, 3 hemimegalencephaly, 2 encephalitis, and 1 trauma. Eighty-eight children went on to resection. Forty-one underwent 3-stage surgery, 47 2-stage surgery (217 total operations). Seventeen had hemispherectomies. Most had 124 electrode contacts implanted. Average duration was seven days from stage 1-2, and six days from stage 2-3. Mean follow-up was three years. Two children have died since surgery. 58/86 (67%) resection patients are seizure free, six (7%) have rare seizures, 10 (12%) have > 50% improvement, and 12 (14%) either were never improved or eventually recurred to their pre-surgical status. Nearly all improved children had accelerated development. Four patients have required reoperation ~ two years postop; three are now seizure free. Six patients required shunts, one had a contralateral SDH, two infections, four positive broth cultures with negative LPs, and three partial bone flap resorption.

Conclusions Epilepsy surgery in young children, performed with a uniform invasive electrode monitoring protocol, entails acceptable risk. Seizure outcome, given most cases were extratemporal, is promising, with 86% of children >50% improved.

## 58. SURGICAL MANAGEMENT OF REFRACTORY NONLESIONAL EXTRATEMPORAL EPILEPSY IN THE PEDIATRIC POPULATION

*Sanjiv Bhatia, MD; Glenn Morrison, MD, FACS; John R. Ragheb, MD, FACS; Catalina Dunoyer, MD; Michael Duchowny, MD; Trevor Resnick, MD; Prasanna Jayakar, MD, PhD (Miami, FL)*

Introduction The absence of a clearly identifiable abnormality on MR imaging makes the task of precisely localizing the seizure onset more difficult. The purpose of this study is to report our results of epilepsy surgery in patients with nonlesional extratemporal epilepsy.

Methods Since 1978, over 530 patients have been operated for intractable epilepsy. Video-EEG monitoring, SPECT scans, MRI and invasive monitoring were used to lateralize and localize the site of seizure onset. There were 205 patients with extratemporal epilepsy. Of these 57 patients were diagnosed as nonlesional based upon the absence of specific structural abnormalities on the MRI scans. Thirty cases had left sided seizure onset. Extraoperative subdural recordings were performed in 50 of 57 patients. Tailored resections with or without callosotomy or multiple subpial transections were performed on the basis of electrophysiological and functional mapping data. Complete resection of the electrophysiologically identified seizure focus was performed in 31 cases.

Results Forty-nine patients had a minimal followup of six months, 30 of 57 patients had over five year followup. More than 90% seizure control was achieved in 60% of cases. This compares favorably to the rate of seizure control in children undergoing epilepsy surgery with a lesion when the completeness of resection is taken into consideration.



Conclusion Intractable epilepsy of extratemporal onset can be treated effectively with carefully tailored resection even in nonlesional cases. Most require extraoperative monitoring with the use of subdural electrodes to identify the epileptogenic focus and for functional cortical mapping

## 59. SEIZURE CONTROL IN CHILDREN WITH LOW GRADE GLIOMAS

*Raja B. Khan, MD; Fredrick A. Boop, MD; Robert A. Sanford, MD (Memphis, TN)*

Introduction There is debate regarding seizure control with lesionectomy versus the necessity of "seizure procedure" (cortical resection of surrounding brain). We aggressively resect low grade gliomas (LGA) reserving seizure procedure for children with inadequate control on anti-convulsants.

Methods Institutional records were reviewed to identify children treated for LGA between January 1985 and 2004. Seizure control was defined as no seizure in six months preceding last follow up.

Results 278 children with LGA, 57 (20%) had seizures; 31 (11%) presented tumor with seizures. 36 (63%) tumors involved cerebral cortex, 14 (25%) subcortical structures and seven (12%) posterior fossa. On MRI, T2 peri-cavity high signal (THS) was present in 19 (33%) and residual tumor in 25 (44%) patients. Median follow up since first seizure is 52 months (range 6-212) and seizures are controlled in 44 (77%). All patients are alive and in follow-up. THS predicted uncontrolled seizures (p=0.05), while presence of residual tumor, shunt, neurologic deficits and abnormal EEG did not (p= 0.1). Ten patients presented tumor with refractory seizures and had lesionectomy (seven complete and three partial); seven are seizure free and three have improved seizure control (all three have THS and one has residual tumor); of the three with partial tumor resection, two achieved seizure control with medical treatment.

Conclusions Surgery and medical treatment control seizures in most children with LGA. Lesionectomy for LGA is an appropriate initial procedure, even in refractory epilepsy. Postoperative THS is risk factor for poor seizure control and seizures can be medically controlled in many patients after sub-total tumor resection.

## 60. COMPLICATIONS OF INVASIVE SUBDURAL GRID AND STRIP ELECTRODE MONITORING AT SAINT LOUIS CHILDREN'S HOSPITAL, 1994-2004

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Introduction Placement of subdural electrodes for invasive video electroencephalography is a widely accepted technique for localization of epileptogenic foci and operative planning. Reported complications include infection, CSF leak, subdural or intraparenchymal hematoma, cerebral edema and transient or persistent neurologic deficit.

Methods The authors retrospectively reviewed the records of 102 consecutive pediatric patients (48 males, 54 females, mean age 10.7y, range 10 months-21 years) with medically intractable epilepsy who underwent invasive monitoring at Saint Louis Children's Hospital between January 1994 and June 2004.

Results There were 111 implantation procedures (77 grids and strips, 27 strips only, seven grids only, one depth electrode) with a mean time of 7.2 days of monitoring (range 1-21 days). There was one acute subdural hematoma requiring craniotomy, one case of osteomyelitis requiring bone flap removal, one chronic subdural hematoma requiring burr hole drainage, one superficial wound infection requiring operative debridement, and one case of electrode breakage requiring removal. Occasional CSF leaks at electrode sites were managed with local oversewing, with one persistent leak requiring reoperation. Overall, there was a 5.4% rate of reoperation for grid-related complications. There were two cases of transient aphasia (one with associated hemiparesis) after grid placement and prior to definitive resection. In addition, there were two cases of aseptic meningitis, one infected pilonidal cyst, one case of otitis media, and one case of diarrhea. There were no permanent neurologic deficits or deaths in the series.

Conclusions Placement of subdural grid and strip electrodes for invasive video electroencephalography is generally safe and well tolerated in pediatric patients.

## 61. PROGRESSION OF SCOLIOSIS AFTER BACLOFEN PUMP PLACEMENT

*Mark J. Puccioni, MD (Omaha, NE); Dale Swift, MD (Dallas, TX)*

Introduction Intrathecal Baclofen delivered through an implanted pump has been shown to be an effective and useful method of controlling spasticity in neurologically injured populations. We have, over time, anecdotally noted that this population of patients appeared to increase and/or develop scoliotic curves. We set out to determine whether intrathecal baclofen changes the curve.

Methods Between 1993-2003 the charts of 102 patients with baclofen pumps were reviewed. Determinations regarding cause of spasticity, age of onset, severity of spasticity (quad versus di versus hemi), ultimate scoliosis surgery were considered. Pre-operative x-rays and post operative x-rays (when available) were reviewed to determine change in curves.

Results Thirty-two of the 102 patients had adequate preoperative AND postoperative films to compare. The average age of diagnosis was 2.60 years (birth-37 years). Age at implant was 13.62 years (0-65 years). Follow-up averaged 3.44 years (0.33- 10.08). The average measurement pre-implant was 18.19 degrees and post-implant was 36.68 degrees. The paired difference pre-op to post-op was 18.49 degrees (Wilcoxon p less than 0.0001). 76% had an increase while 14.7 had a decrease in the curves. The rest had no change. The average change in curvature for the entire group was 5.00 degrees/year.

Conclusions The literature quotes rates of change (based on shape of curve) between 2.3 and 3.5 degrees/year for scoliotic curves. Our statistics were based on our entire population and did not distinguish based on curve shape. Our rate, even in combination was up to twice than would be expected by natural history.

## 62. ENDOSCOPIC SURGERY OF HYPOTHALAMIC HAMARTOMA (HH) ASSOCIATED WITH REFRACTORY CATASTROPHIC EPILEPSY IN PEDIATRIC PATIENTS

*Iman Feiz-Erfan, MD; Eric M. Horn, MD, PhD; Harold L. Rekate, MD; Yu-tze Ng, MD; Jeffrey D. Klopfenstein, MD; L. Fernando Gonzalez, MD; Gregory P. Lekovic, MD, JD; John F. Kerrigan, MD (Phoenix, AZ)*

Introduction Surgery remains the best option to treat refractory epilepsy associated with HH. Most procedures consist of transcallosal or pterional approaches. We review our interim data after pure endoscopic surgery for this condition.

Methods Between 1997-2004, eight pediatric patients (five males, three females; mean age, 8.5 years; range 3-16 years) presented with refractory epilepsy and gelastic seizures associated with a HH and underwent pure endoscopic surgery to treat their condition. These patients had an average of 20 seizures a day. Most were developmentally delayed and had behavioral abnormalities.

Results There were no deaths. One transient hemiparesis resulted from a small perforating artery injury. When possible, most HHs, which ranged from 5 to 32 mm, were resected. Follow up ranged from 1-84 months. Five patients had no further seizures. Seizure frequency was reduced by 95% in three patients. Behavioral and cognitive function improved in five and four patients, respectively. Some patients experienced a decrease in overall energy or an increase in appetite. Five patients had mild and mostly transient short-term memory difficulties. No permanent endocrinological deficits occurred.

Conclusions Our interim data indicate that refractory epilepsy associated with HH can be treated effectively with endoscopic surgery. This approach is particularly suited for patients with refractory and catastrophic epilepsy when the third ventricle is not fully obstructed by the lesion. The options of resection or disconnection of the HH are discussed.

## 63. FEASIBILITY OF THE ENDONASAL TRANSSPHENOIDAL APPROACH IN THE TREATMENT OF PITUITARY TUMORS IN CHILDREN

**Kenneth Shulman Award Candidate**

*Marcus L. Ware, MD; Charles B. Wilson, MD; Sandeep Kunwar, MD (San Francisco, CA)*

Introduction Pituitary adenomas are uncommon in childhood and adolescence. Medical treatment of pituitary tumors is effective in some cases. Surgical resection should be considered in patients where vision is threatened or in cases where the effects of the tumor or side-effects of medical therapy are intolerable. The endonasal transsphenoidal approach is a safe and effective technique for tumor removal in adults. Here we review our experience with this technique in children.

Methods We reviewed the charts of 26 children treated surgically for pituitary tumors between 1998 and 2004. There were eight males and 18 females operated. These patients ranged from 7 years old to18 years old (mean of 16 years old). Thirteen operations were performed using the sublabial transsphenoidal approach and 14 using the endonasal approach based upon the preference of the surgeon.

Results There were six patients (23%) with Cushing's disease, 14 (54%) with prolactinomas and three (12%) with growth hormone-secreting tumors. Twelve of 18 girls presented with menstrual irregularities. Two patients presented with galactorrhea, three presented with gigantism, and one patient presented with apoplexy. There were 19 gross total resections (GTRs) in 27 surgeries. There were10 GTRs (77%) using the sublabial approach and nine GTRs (64%) using the endonasal approach. GTR was limited by tumor extension beyond the pituitary fossa in two cases where the endonasal technique was used. There were no intraoperative complications and good visualization of pituitary fossa in all cases.

Conclusions The endonasal and sublabial approach are both safe and effective in treating children with pituitary tumors.

## 64. LOW-FRONTAL TRANSVENTRICULAR ENDOSCOPIC APPROACH TO THE PINEAL REGION

*Jonathan E. Martin, MD (Honolulu, HI); James M. Ecklund, MD; Robert F. Keating, MD (Washington, DC)*

Introduction Endoscopic biopsy is an accepted technique of obtaining tissue diagnosis in pineal region pathology. Biopsy via a pre-coronal burr hole may allow the surgeon to simultaneously perform endoscopic third ventriculostomy to treat hydrocephalus. This trajectory can make performance of a biopsy of a mass in the posterior third ventricle difficult. The indirect view provided by angled or flexible endoscopes increases the risk of injury to neurovascular structures in the region of the foramen of Monro, particularly in the hands of inexperienced endoscopists. We present our experience with an alternative trajectory for endoscopic access to this region.

Methods The endoscope is inserted via a low-frontal trajectory through a supraciliary incision. Procedures are performed with zero or five-degree rigid endoscopes and biopsy forceps.

Results We have utilized this approach on four patients. One patient underwent successful fenestration of a pineal cyst for treatment of obstructive hydrocephalus. Tissue diagnosis was obtained on three other patients with pineal region tumors. No complications occurred. All patients had acceptable cosmetic results.

Conclusions Low-frontal transventricular endoscopic biopsy is alternative minimally invasive approach to posterior third ventricular pathology.

## 65. ENDOSCOPIC RESECTION OF SOLID INTRAVENTRICULAR TUMORS

**Kenneth Shulman Award Candidate**

*Neal Luther; Mark M. Souweidane, MD (New York, NY)*

Introduction Endoscopic removal of intraventricular brain tumors is well established for cystic tumors such as colloid cysts. Cyst aspiration followed by removal or ablation of the membranous wall is feasible given the constituent features of these tumor types. Expectantly, the complete removal of solid brain tumors from the intraventricular compartment using the endoscope would create additional technical demands. From a recent cohort of patients undergoing endoscopic tumor management, the feasibility of solid tumor removal was reviewed.

Methods Five patients who presented with solid intraventricular brain tumor were recently offered endoscopic treatment. A solid lens endoscope was used to cannulate the ventricular compartment and identify the tumor morphology. Solely through the working channel, bipolar diathermy, piecemeal sampling, sharp dissection, YAG laser, and catheter aspiration were used in an attempt to remove the lesion. Patient selection, surgical technique, morbidity, and extent of removal are reviewed in the context of this series of patients.

Results The procedure ranged from 90-180 minutes. Maximal tumor diameter ranged from 1.2-2.5 cm. Four patients had complete tumor removal confirmed by postoperative imaging. No patient experienced significant surgical morbidity. One patient required the placement of an indwelling ventricular catheter at the time of tumor resection, and one required an additional surgical procedure for tumor resection. Hospital stay ranged from 2-3 nights, and no patient has had symptomatic or radiologic evidence of disease recurrence.

Conclusions In select patients, endoscopic removal of solid intraventricular brain tumors is possible and safe. The technique requires rigid patient selection, refined instrumentation, and a disciplined surgical technique.

## 66. THE ROLE OF ENDOSCOPIC MINIMALLY INVASIVE CRANIOTOMY FOR THE TREATMENT OF SCAPHOCEPHALY

*Ian M. Heger, MD; Eric Stelnicki, MD; Drew Schnitt, MD; Luis Rodriguez, MD (Hollywood, FL)*

Introduction Although the indications for surgical correction of saggital synostosis are quite clear, there are numerous different surgical techniques to correct it. Although many surgical techniques exist for the correction of craniosynostosis, most of these procedures require large incisions, and blood loss requiring transfusion remains a significant problem. We report our experience with a technique which utilizing endoscopic assistance for visualization and specially designed surgical instruments.

Methods Between June 2003 and June 2004, 55 surgical procedures for craniosynostosis were performed. Thirty-six surgical procedures were performed for saggital synostosis. Of these, 13 open cranial vault remodeling procedures were through a standard incision. The cranial vault was reconstructed using resorbable plates and screws. In 23 cases, using endoscopic visualization and specially designed instruments, a wide vertex and occipital craniectomy was performed, and barrel-stave osteotomies were made to widen the biparietal diameter. Molding helmets were worn postoperatively.

Results There was no difference in the post operative cranial index between the two groups. In patients who underwent the traditional cranial vault remodeling, average blood loss was 225 cc, operative time was 3.5 hours, and hospital stay was 4.5 days. For patients who underwent the minimally invasive procedure, average blood loss was 55cc, operating time was 1.5 hours, and hospital stay was 2.5 days.

Conclusions Endoscopic cranial vault remodeling is a safe and acceptable alternative treatment for the treatment of craniosynostosis. It has the potential to provide execellent aesthetic results while decreasing operative blood loss, hospital length of stay, and patient satisfaction.

## 67. ENDOSCOPIC MANAGEMENT OF SUPRATENTORIAL INTRA AND PARAVENTRICULAR CYSTS

*Gianpiero Tamburrini, MD; Massimo Caldarelli, MD; Luca Massimi, MD; Rossana Romani, MD; Griselda Ramirez-Reyes, MD; Concezio Di Rocco, MD (Rome, Italy)*

Introduction Neuroendoscopic fenestration is actually considered the treatment of choice in patients with intraventricular and paraventricular cysts. However controversies still exist on the need to combine or not ventriculocystostomy with ventriculo or cisto-cisternostomy so as on how to manage children with associated hydrocephalus.

Methods From March 2002 to June 2004 we endoscopically treated (rigid Storz endoscope) 15 patients (M/F=12/3, mean age=4.9 years) with supratentorial intra or paraventricular cysts.

Results Patient population consisted of: six children with intraventricular quadrigeminal plate arachnoid cysts ; five patients with secondary intraventricular cysts in previously shunted hydrocephalus ; three children with paraventricular arachnoid cysts and one with a choroid plexus cyst. Cyst marsupialization was the only treatment in nine patients; a third ventriculostomy (three cases) and a shunt revision (three cases) were contemporarily performed in six children. Surgical complications were represented by one case (6.6%) of CSF leakage from the surgical wound. Recurrence of the cystic lesion was observed in two patients (13.3%) who both underwent a second neuroendoscopic cyst marsupialization. Complete resolution of preoperative clinical manifestations was obtained in 92.3% of the patients; a partial improvement was obtained in one case . Control MRIs (MFU: 12.1 months) show a significant reduction of the cyst size in 13 cases and a detension of the cyst wall in two patients.

Conclusions Our experience confirms that neuroendoscopy should be the technique of choice in children with intraventricular and paraventricular cysts. Ventriculocisternostomy or shunt revision should be considered only in children with associated hydrocephalus

## 68. SHOULD ENDOSCOPIC THIRD VENTRICULOSTOMY BE THE PRIMARY TREATMENT FOR PEDIATRIC HYDROCEPHALUS IN THE SUDAN

**Hydrocephalus Award Candidate**

John Thorne, MD; Jerard Ross (Salford Manchester, United Kingdom); Aziza El Naeema, Sobeh (Khartoum, Sudan); Carys Bannister (Manchester, United Kingdom)

Introduction Hydrocephalus is an important cause of morbidity and mortality in the developing world. In the Republic of the Sudan it is managed predominantly by pediatric surgeons as there are only three consultant neurosurgeons for a population of 33 million. Given the expanding indications for the use of endoscopic third ventriculostomy (ETV) in the developed world and the relatively lesser cost implications we have attempted to introduce ETV into the management paradigm for, primarily, pediatric hydrocephalus in the Sudan.

Methods As part of a British Council sponsored project aimed at improving the management of children with spina bifida in the Sudan we were asked to perform endoscopic third ventriculostomies with a Sudanese pediatric surgeon.

Results In two short visits over the last year we have performed 22 ETV for hydrocephalus of mixed aetiology. The median age was 6 months and the most common diagnosis was that of congenital obstructive hydrocephalus, the next most frequent being hydrocephalus secondary to spina bifida. Ventricles varied in size from moderately enlarged to huge. Eighteen were technical successes with sixteen clinical successes (not requiring subsequent ventriculoperitoneal shunting). Fifteen of the cases were performed by a local surgeon with our assistance and guidance.

Conclusions Although this is a small series with necessarily limited follow-up we believe that ETV represents a cost-effective and useful clinical intervention in this population. We discuss the complex issues of hydrocephalus management in the Sudan.

## 69. HEMMORHAGIC SEQUELAE OF ENDOSCOPIC SURGERY FOR INTRAVENTRICULAR TUMORS IN THE PEDIATRIC POPULATION

*Anders J. Cohen, DO; Mark M. Souweidane, MD (New York, NY)*

Introduction The inability to achieve hemostasis is purported to be a significant limitation of endoscopic surgery for intraventricular brain tumors. However, the true incidence of clinically significant hemorrhage from endoscopic biopsy or resection of brain tumors is poorly understood.

Methods All pediatric procedures in which the authors performed an intraventricular endoscopic tumor biopsy or resection over a 10 year period were reviewed. Significant sequelae resulting from hemorrhage were recorded including: converting the procedure to an open craniotomy, aborting the procedure, treating post hemorrhagic hydrocephalus, or identifying symptoms of intraparenchymal hemorrhage.

Results Thirty-five endoscopic procedures were performed in 35 patients ranging in age from 2 months to 20 years. Thirty-two patients underwent endoscopic tumor biopsy and three underwent tumor resection. Twenty-one simultaneous procedures were performed: endoscopic third ventriculostomy (8), ventriculoperitoneal shunting (6), endoscopic septostomy (6), and tumor cyst fenestration (1). The site of tumor work was categorized as: lateral ventricular (5), and third ventricular (30). The intended surgical goal (tumor biopsy or resection) was achieved in 34 of 35 procedures. One endoscopic tumor biopsy was aborted due to poor visualization from hemorrhage. No patient demonstrated a new postoperative neurological deficit necessitating imaging. Nine patients had an externalized ventricular drain placed at the time of the primary procedure, all of which were successfully weaned.

Conclusions Clinically significant hemorrhage associated with primary neuroendoscopic tumor management is a very rare event. Based upon the results for this study, concern regarding hemorrhagic sequelae should not serve as a contraindication against endoscopic biopsy or resection of intraventricular brain tumors.

## 70. CONTINUOUS SPINAL DRAIN FOLLOWING ENDOSCOPIC 3RD VENTRICULOSTOMY: CHANGING THE DEFINITION OF FAILURE

*Shlomo Constantini, MD; Pinar Ozisik, MD; Jonathan Roth, MD; Liana Beni-Adani, MD (Tel Aviv, Israel)*

Introduction This study evaluates safety, efficacy, and indications for continuous lumbar drainage (CLD) in patients experiencing pressure following endoscopic third ventriculostomy (ETV).

Methods and Results We retrospectively reviewed clinical data of 22 consecutive patients treated between 1996 and 2001 with CLD after ETV. Decision to insert a CLD was made in selected ETV patients. CLD was inserted in cases of high ICP (12 patients), clinical symptoms indicative of continuing hydrocephalus (two patients), and "prophylactically" in eight patients, based either on clinical condition of patients before ETV or on technical difficulties during ETV procedure, which seemed to increase the risk of ETV failure. CLD insertion took place either in the operating room immediately following the ETV procedure, or under very specific conditions and with close patient monitoring in an ICU setting. Only four patients eventually required shunting, all within one month after ETV. Therefore, the overall ETV success rate was 81.8% (18/22 patients). Of the 14 patients suffering measured or clinically observed continuing hydrocephalus, 12 (85%) ultimately recovered without need for a permanent shunt. Without the CLD, some of these patients would probably have been declared 'failures' and referred for a standard shunt. CLD provided a window of opportunity after ETV for the absorption system to recover and return to full functionality.

Conclusions Selective usage of CLD is a reasonable and safe method to gain time and facilitate the recovery of absorption capacity following ETV. CLD, should be attempted before conceding a post-ETV patient as a failure.

## 71. STRATEGY FOR COPING WITH THE NEW NEUROSURGICAL RESIDENCY 80 HOUR WORK WEEK IN A BUSY PEDIATRIC EMERGENCY DEPARTMENT

*Stephanie L. Einhaus, MD; Michael Muhlbauer, MD; Frederick Boop, MD; Robert Sanford, MD (Memphis, TN)*

Introduction The new neurosurgical residency work rules which began July 2003 created staffing shortages in our training program and forced changes in neurosurgical resident coverage in our busy pediatric emergency department.

Methods A set of guidelines were developed by the authors regarding management of shunt patients and neurosurgical trauma patients in the emergency department prior to July 1, 2003. These were given to the emergency department medical staff and have been utilized over the past year since July 1, 2003.

Results The guidelines and our experience with them will be discussed. We have successfully reduced the number of "frivolous" consults that the neurosurgical house staff have had to see in the pediatric emergency department. There were three failures with the system. Two shunt patients were sent home who were found to have partial shunt malfunctions in follow up and had surgery one week later, and one trauma patient would have been managed differently if it had been seen by the resident. However, there was no additional morbidity associated with any of these three patients due to the management strategy failure. Pros and cons of this strategy will be discussed.

Conclusions A strategy can be devoloped and safely utilized to reduce the number of pediatric emergency consults requested of the neurosurgical house staff in order to comply with the new 80 hour work week rules.

## 72. THE ADULT PRACTICE OF PEDIATRIC NEUROSURGERY: CLINICAL, REFERRAL, AND FINANCIAL ISSUES

*David Frim, MD, PhD; Rita Martin-Douglas, MBA (Chicago, IL)*

Introduction Though pediatric neurosurgery is traditionally restricted to patients under 18 years, "pediatric" neurosurgical procedures performed in adult patients have been deemed acceptable for ABPNS re-certification. To investigate the nature of "adult" pediatric neurosurgery, we examined the clinical, referral, and financial aspects of such a mixed practice.

Methods Procedural codes, diagnosis, age, billed and collected charges, insurance carrier, and referral sources were retrospectively examined from our institutional pediatric neurosurgery databases for fiscal years 2002 and 2003.

Results 1,131 procedure codes were submitted: 840 (74%) in children (18y). Distribution of diagnoses was similar in both age groups for "pediatric" diagnoses (e.g., Hydrocephalus, 29% and 31%, respectively; Spina Bifida 4% and 6%) but different where adult neurosurgeons had developed recognized expertise (e.g., Epilepsy, 3% and 10%; trauma, 0% and 6%). Children were most commonly referred by pediatricians; adults by self-referral or adult neurosurgeons. Financially, the collection rate for adults (40%) was significantly greater ($p<0.005$) than that for children (32%).

Conclusions In our database, the adult practice of pediatric neurosurgery consists of pediatric problems for which there is no recognized adult neurosurgical subspecialty. Referral patterns suggest a lack of training or availability of adult neurosurgeons to manage these problems. Interestingly, third party re-imbursement for adults with these problems is significantly greater than that for pediatric patients. These observations show a need and potential incentive for an adult practice of pediatric neurosurgery and may argue for including selected adult case material in pediatric neurosurgical training.

## 73. IMPACT OF A NURSE PRACITIONER ON A PEDIATRIC NEUROSURGICAL SERVICE

*Judie Holleman, MSN, RN; David Frim, MD, PhD (Chicago, IL)*

Introduction The introduction of the 80 hour work week regulations has challenged resident training programs to creative scheduling while maintaining comprehensive training experiences. The restrictions may be adaptable to medical services, but have been more challenging to an academic surgical program. The particular challenges include optimizing academic learning opportunities, operating experiences, and patient care, while adhering to the regulations. This paper examines adding a nurse practitioner to a pediatric neurosurgical program, in response to the resident work restriction.

Methods A 1-10 rating scale was distributed to 23 physicians, nurses and social services. Participants were asked retrospective rating of satisfaction with the service's availability, responsiveness and clinical satisfaction before the NP addition, and after one year. The hospital paging log was also reviewed and compared with times and days when the NP was not available. Finally, the record of sentinel events before and after were reviewed.

Results The results demonstrated significant increase in satisfaction scores ($p<.005$). In particular,overall satisfaction improved from mean of 4.2 to 9. The number of paging calls received by the NP was increased compared to the residents. The sentinel events decreased,(from 2 to 0) despite increased complexity and increased volume of surgical cases performed.

Conclusion The addition of an NP to a pediatric neurosurgical service has had a positive impact on patients' safety and staff satisfaction. Presumably this will allow concurrent improvement in the resident's ability to devote adequate time to academic and training experiences.

## 74. VIRTUAL REALITY AS A TRAINING TOOL FOR ENDOSCOPIC NEUROSURGICAL PROCEDURES

**Hydrocephalus Award Candidate**

*Sunil Manjila, MD; M. Cenk Cavusoglu, PhD; Nathan Brown; Alan R. Cohen, MD (Cleveland, OH)*

Introduction Despite the widespread popularity of minimally invasive endoscopic neurosurgery, there is currently no existing standardized method for training in this field. We have developed a computer-generated virtual reality technique to train surgeons how to perform neuroendoscopic procedures.

Methods In a multidisciplinary collaboration among neurosurgeons, electrical engineers and computer scientists at our institution, we have created a virtual reality surgical simulator combining magnetic resonance imaging data with a haptic interface workstation.

Results A reliable and extremely precise prototype simulator was developed. Magnetic resonance imaging data were converted into geometric polygons and rendered on a computer screen, replicating the visual, mechanical and behavioral aspects of brain tissue. The haptic hand controllers and visual display of the operative site allowed trainees to manipulate endoscopic surgical instruments in a virtual environment with tactile feedback. We have used the system to simulate endoscopic third ventriculostomy for hydrocephalus and endoscopic procedures for neoplasms and cysts.

Conclusions Virtual magnetic resonance endoscopy with haptic interfaces can be used to create highly realistic and interactive simulations of endoscopic neurosurgical procedures, thus serving as a powerful training tool.

## 75. USE OF RAPID MRI TECHNIQUES IN UNSEDATED CHILDREN

**Hydrocephalus Award Candidate**

*Patricia B. Quebada, MD; Alex Mamourian, MBA; Reyaad Hayek; Ann-Christine Duhaime, MD (Lebanon, NH)*

Introduction In January 2003, we began to use rapid MRI techniques in selected hydrocephalic children. Because of the favorable results, we have expanded this technique for a number of additional indications. We report our initial experience with these techniques.

Methods Between January 2003 and May 2004 we performed 103 rapid MRI studies in unsedated children (age range 3 months to 14 years). Specific techniques included fast-spin-T2-weighted imaging (scan time is approximately 30 seconds). More recently, we have also included "Moving Target" MRI protocols.

Results 103 scans were performed. No child failed scanning and required sedation. The most common indication for the scan was evaluation of ventricular size for shunted hydrocephalus with screening for macrocephaly the second most common indication. Unexpected findings included Chiari malformations, extra-axial collections, and syringomyelia. These techniques were reliably able to identify benign enlargement of the subarachnoid spaces. Parent satisfaction was extremely high and the cost was equivalent to CT scans. With this technique, radiation exposure is avoided.

Conclusions Rapid MRI scanning offers a number of potential advantages over CT scanning for specific indications. Newer "Moving Target" techniques allow for improved resolution. We are currently investigating experimental protocols to expand these techniques for additional indications, such as identification of hemorrhage.

## 76. HEPARIN BINDING EPIDERMAL GROWTH FACTOR (HB-EGF) OVEREXPRESSION IS IMPLICATED IN THE DEVELOPMENT OF HYDROCEPHALUS IN TRANSGENIC MICE

**Hydrocephalus Award Candidate**

*Bart A. MacDonald, MD; Gerhard Raab, PhD; Katshutoshi Goishi, MD, PhD; Sun Yanping, PhD; Eichiro Nishi, PhD; Nina Irwin, PhD; Michael Klagsbrun, PhD; Joseph R. Madsen, MD (Boston, MA)*

Introduction Transgenic models of hydrocephalus offer insights into mechanisms which may be targeted therapeutically. We report a new "knock in" model of hydrocephalus resulting from the heparin binding EGF gene, and demonstrate an epigenetic influence of sex hormones.

Methods Transgenic mice constitutively over-expressing HB-EGF were created by a plasmid insertion technique. Unexpectedly, many of the mice developed hydrocephalus observed by cranial doming, which was often fatal. The presence of the human HB-EGF transgene was determined by PCR analysis of tail sections. Quantitative MRI was used to determine volumes of CSF spaces within the cranium.

Results Hydrocephalus is clinically evident by head doming and failure to thrive in 4% of the offspring of this HB-EGF expressing line. MRI imaging of 51 animals with apparently normal heads and behavior from seven litters revealed that 33% had hydrocephalus defined by volume measurement greater that 40 mm3. MRI and preliminary histology suggests communicating hydrocephalus. All animals that developed hydrocephalus had the trangene by PCR and no animals without the transgene developed hydrocephalus. Female animals had nearly double the incidence of ventriculomegaly (12/25 v. 5/26; 48% vs. 19.2%; chi square = 4.75; p=0.04, Fisher's exact test). The ventricular volume also was larger in females than males (113+/-36 vs. 34+/-15 mm3, p=0.02, Mann-Whitney U test).

Conclusions The HB-EGF transgene induces hydrocephalus by an unknown mechanism, potentially mediated by estrogens or other hormones (for which there is precedent in other tissues). A role in humans could suggest a pharmacological adjunct in the treatment of this problem.

## 77. CHARACTERIZATION OF MURINE CD133+ CEREBELLAR STEM CELLS AND MURINE MEDULLOBLASTOMA STEM CELLS

*Sharon Chiappa, PhD; Corey Raffel, MD, PhD (Rochester, MN)*

Introduction Medulloblastoma differentiates along neural and glial lines. Stem cells may be responsible for the growth of this tumor. We hypothesize that genetic events leading to the unregulated growth of medulloblastoma can be identified and studied by comparing the properties of normal cerebellar stem cells to medulloblastoma stem cells. We used a murine model of medulloblastoma to address molecular alterations occurring in this tumor.

Methods and Results CD 133+ neural stem cells have been isolated from murine cerebellum. Neurospheres developed from CD133+ cells from embryonic samples, and from postnatal days one, three, and five. By postnatal day 10, less neurospheres were seen and no neurospheres developed from postnatal day 20 cells. CD133+ and CD133- cells from a tumor occurring in a Ptch_+/- mouse have also been isolated. The positive cells grow as "tumor spheres." The neurospheres from normal cerebellum were placed into culture conditions favoring differentiation. The cell differentiated into 5-10% astrocytes; 60-70% neurons; and 10-20% oligodendrocytes. When CD133+ tumor spheres were place into similar conditions, up to 90% of cell underwent neuronal differentiation. The gene expression profile of normal murine external granule cell layer cells; and CD 133+ Ptch tumor stem cells have been compared using the Affymetrix high density mouse genome 430 2.0 array. Interestingly, expression of EN1, a gene required for cerebellar development, and Ptch2 are markedly downregulated in the tumor.

Conclusions Insights into medulloblastoma can be gained by comparison of normal to tumor stem cells.



## 78. THE EFFICACY OF DURAGEN AS A DURAL SUBSTITUTE FOLLOWING CHIARI DECOMPRESSION

**Kenneth Shulman Award Candidate**

*Shabbar F. Danish, MD; Amer Samdani, MD; Amgad Hanna, MD; Michael F. Stiefel, MD, PhD; Phillip Storm, MD; Leslie Sutton, MD (Philadelphia, PA)*

Introduction Suboccipital decompression is routinely used for the treatment of Chiari malformations. The efficacy of this procedure has been traditionally believed to require a water tight seal with primary closure of the dura with either pericranium or allograft. We evaluated the use of a synthetic dural substitute, Duragen, (Integra Neuroscience, Plainsboro, NJ) that does not require sutures as the duraplasty following suboccipital craniectomy (SOC) in this patient population.

Methods Twenty-eight patients including 23 diagnosed with Chiari I malformations and five with Chiari II who underwent SOC and C1 laminectomy were retrospectively evaluated. During the procedure, the dura was opened widely with visualization of the 4th ventricle. In all but four patients, the arachnoid was opened as well. Duraplasty was performed by applying Duragen over the dural defect. All patients were assessed for the presence of a pseudomeningocele, wound infection, CSF leak, and the need for reoperation either for wound revision or the placement of a ventriculoperitoneal shunt.

Results All patients tolerated SOC without operative complications. Lumbar drains were not placed. The mean age of patients at diagnosis was nine years (median= 11). The mean length of follow up was 17.5 months (median= 19). Of the Chiari I patients, seven had evidence of a syrinx at the time of operation. There were two pseudomeningoceles, no wound infections, no CSF leaks, and as a result no reoperation was required in any patient.

Conclusions The dural substitute, Duragen, provides an effective dural barrier following SOC and permits a rapid dural repair with very low postoperative morbidity.

## 79. PROPER SELECTION CRITERIA FOR SURGICAL MANAGEMENT OF BIRTH RELATED BRACHIAL PLEXUS PALSY

**Kenneth Shulman Award Candidate**

*Keyne K. Thomas, MD; Richard D. Goldner, MD; Timothy M. George, MD (Durham, NC)*

Introduction Selection criteria for surgical intervention of obstetrical brachial plexus palsy (OBPP) continue to be controversial. We analyze our criteria for surgery and specifically relate it to outcome.

Methods We retrospectively analyzed 30 consecutive patients with OBPP who were referred after failure of conservative management. Each patient was evaluated for age, neurological status, pre-op imaging, electrophysiological studies (pre and intra-op), and surgical technique.

Results Eleven patients were selected for surgical intervention based on age greater than or equal to 6 months, poor upper extremity function using the Toronto Muscle Grading system (TMG) and EMG demonstrating brachial plexopathy. Surgery included neurolysis (n=11) and direct neurontization using pectoral nerves (n=1) after no improvement on intra-op EMG following neurolysis. Postoperatively 54% had significant improvement (greater than or equal to three point increase on TMG). 27% had moderate improvement (greater than or equal to two point increase on TMG). Only one patient had minimal improvement (greater than or equal to one point increase on TMG). One patient who underwent neurolysis of the upper trunk had improvement of deltoids and biceps but worse function of hand intrinsics due to contractures resulting in an eight point decrease on TMG.

Conclusions Surgical treatment of OBBP achieved good results with proper patient selection, preoperative evaluation, timing of surgery, intraoperative evaluation and surgical procedure performed.

NOTES

# ELECTRONIC POSTER INDEX





# ELECTRONIC POSTER ABSTRACTS

## 101. DIFFUSION TENSOR IMAGING AND FIBER TRACKING OF SOMATOSENSORY AND MOTOR WHITE MATTER TRACTS FROM CORTICAL POINTS DEFINED BY MAGNETIC SOURCE IMAGING IN PATIENTS WITH LARGE ARTERIOVENOUS MALFORMATIONS


*Daniel A. Lim, MD, PhD; Pratik Mukherjee, MD, PhD; Srikantan Nagarajan, PhD; Nalin Gupta, MD, PhD (San Francisco, CA)*


Introduction Magnetic resonance diffusion tensor imaging (DTI) combined with magnetic source imaging (MSI) has been used to track ascending and descending white matter tracts in normal brain as well as those with neoplasms. We used DTI to track somatosensory and motor fibers from cortical points defined by MSI in two pediatric patients with Spetzler grade four and five arteriovenous malformations (AVMs). Subcortical localization of motor and sensory pathways in relation to AVMs may provide valuable information to help guide treatment

Methods A 12-year-old boy with a 6 cm left parietal AVM (Spetzler grade 5) and a 16-year-old girl with a 5 cm left posterior frontal-parietal AVM (Spetzler grade 4) were studied. Both patients underwent MR imaging on a 1.5T scanner. Whole-brain DTI was performed using a single-shot multislice spin echo echoplanar sequence with isotropic 2-mm spatial resolution and a diffusion-weighting factor of 1000 sec/mm2. Fifteen diffusion gradient directions and one image set without diffusion weighting were acquired using parallel imaging with an 8-channel head coil for improved signal-to-noise ratio and reduced echoplanar image artifacts. MSI data from somatosensory stimulation and motor tasks were used to identify sites of sensory and motor cortex, and these MSI-defined points were used to launch the subcortical fiber tracking. DTI tractography was performed using the fiber assignment by continuous tracking (FACT) method.

Results In both patients, DTI from MSI-defined cortical points revealed the location of ascending and descending fiber tracks in relationship to the AVMs. The local distortion of the fiber tracks by the AVM could be visualized. Currently, cortical motor regions as defined by MSI data are broader than the somatosensory points; however, DTI for descending motor pathways could be successfully determined. We are currently attempting to define the appropriate threshold for mapping motor cortex with MSI and defining an optimal region of interest to determine corticospinal tracts accurately by DTI.

Conclusions DTI combined with MSI can be used to track subcortical motor and somatosensory fibers in older pediatric patients with AVMs. This method has the potential to reduce treatment morbidity by revealing the subcortical pathways of eloquent cortex. The merging of functional brain imaging with white matter tractography will be important for future studies of both the normal and pathologic brain, and as an adjunct for treatment planning.

## 102. OUTCOME FOLLOWING SURGICAL REVASCULARIZATION IN PATIENTS WITH MOYAMOYA SYNDROME AND DOWN SYNDROME


*Andrew Jea, MD (Miami, FL); R. Michael Scott, MD (Boston, MA)*


Introduction We wished to describe the clinical features of moyamoya syndrome in children and adults with Down syndrome, and to determine the results of surgical revascularization in this patient population at late follow-up.

Methods We reviewed the records of patients with moyamoya syndrome associated with Down syndrome in a consecutive series of 181 patients who underwent primary revascularization surgery for cerebral ischemia from January 1, 1985 to December 31, 2003.

Results Sixteen patients, six males and 10 females, with moyamoya syndrome and Down syndrome were operated on during this period. Average age of onset was 9.3 years (range 1 - 29); average age at surgery was 9.8 years (range 2 - 29). As anticipated in this patient population, many of the patients had a history of congenital heart disease, and several had interesting histories of frequent head and neck or respiratory infections. Most patients presented with TIA or stroke confirmed by preoperative CT and MRI. Pre-operative angiography demonstrated presence of bilateral disease in all patients. All patients underwent a standard surgical treatment -- pial synangiosis; the average length of follow-up was 39.8 months (range 0 - 103). Complications included subdural hematoma, new seizure disorder, and ischemic infarct. Only one patient had worsened neurologic status at late follow-up.

Conclusions The clinical and radiographic features of moyamoya syndrome associated with Down syndrome are comparable to those of primary moyamoya disease. Revascularization surgery appears to stabilize the neurological status of most patients with this syndrome.

## 103. CELLULAR SUBSTRATE FOR THE STUDY OF CSF TRANSPORT: THE MOUSE LEPTOMENINGEAL CELL CULTURE


*Cornelius H. Lam, MD; Jing Xiao, PhD; Walter C. Low, PhD (Minneapolis, MN)*


Introduction Many genetic diseases have hydrocephalus as a component of their clinical spectrum. The arachnoid cell is an important component of arachnoid granulations. Establishing an arachnoid cell line in the mouse opens the door for physiological study thorough an array of transgenic animals previously not available.

Methods Six animals underwent posterior fossa craniectomy and complete cervical, thoracic, and lumbar laminectomy. The dura was opened from the transverse sinus to the conus. The brainstem was transected and lifted from the skull base. Cranial nerves were divided as well as the spinal nerve roots. The cord was removed, and a dorsal cut in the pia was made from the obex to the conus. The leptomeninges were then stripped from the underlying neural tissue. Three animals had suitable arachnoid that was then macerated and placed in culture. Dulbecco's MEM with 10% fetal bovine serum and antibiotics was the culture medium used. The tissue was incubated at 37 degrees in 5% CO2. Passages were performed with D-PBS.

Results Cobble stoning of the arachnoid tissue began on the first day. On day six, adhesion took place onto the plastic well, where they assumed similar cellular characteristics to human arachnoid cell lines. Cells survived passaging and dissociation to again be adherent on day eight (post-passage day one).

Conclusions Mouse arachnoid culture has been difficult to establish because of its diaphanous and microscopic nature. Careful dissection permits exclusion of most other tissues from culture. These cell lines could be the basis for comparison between normal and hydrocephalic transgenic mouse models.

## 104. SURGICAL THERAPY FOR REFRACTORY EXTRATEMPORAL NONLESIONAL FOCAL EPILEPSY IN CHILDREN

*Shenandoah Robinson, MD; Monisha Goyal, MD (Cleveland, OH)*

Introduction Extra-temporal nonlesional intractable focal epilepsy in children is notoriously difficult to treat. We have pursued an aggressive surgical approach to localize and resect seizure foci in these children.

Methods All patients underwent a pre-surgical evaluation including video-EEG, neuroimaging and neuropsychological testing. None had a tumor, vascular malformation, phakomatosis, or hemispheric involvement.

Results Twenty-one consecutive children with extratemporal nonlesional seizure foci underwent invasive monitoring. Mean age at initial surgery was 9 years (1-16 yrs). Resection sites were frontal (11), parietal (6), frontal and parietal (2), and parietal and occipital (2). Three patients had undergone temporal lobectomy. Pathology showed focal cortical dysplasia in eight and gliosis in 11. Mean follow-up was 27.5 months. Nine children (43%) became seizure-free (Engel I), 2 had only auras, and eight had more than 80% reduction in seizure frequency (Engel III). Only two children had no significant improvement in seizure control. Three children had transient weakness after resection, and one had permanent worsening of her baseline hemiparesis secondary to cerebral edema. Four patients with recurrent seizures underwent repeat invasive monitoring. Two became seizure-free, one after two further resections plus vagal nerve stimulator insertion and placement on a modified ketogenic diet. Most children experienced a marked improvement in cognitive ability associated with improved seizure control and medication reduction.

Conclusions We conclude advanced neuroimaging techniques and an aggressive surgical approach can identify patients who were previously not considered good surgical candidates. Although not without risks, this strategy provides children with nonlesional extra-temporal intractable epilepsy an opportunity for a much improved quality of life.

## 105. CHIARI 1 MALFORMATION IN ASSOCIATION WITH FG SYNDROME

*Oren N. Gottfried, MD; John M. Opitz, MD; Marion L. Walker, MD (Salt Lake City, UT)*

Introduction FG syndrome is an X-linked, incompletely recessive disease characterized by mental retardation, congenital hypotonia, constipation, subtle facial anomalies, seizures, agenesis of the corpus callosum, and behavioral abnormalities. It has been observed on magnetic resonance imaging (MRI) that some patients have tonsillar ectopia. We describe a unique association between Chiari 1 malformation and FG syndrome and attempt to determine the optimal treatment of these patients.

Methods We performed a retrospective chart and radiology review of 144 pediatric FG syndrome patients for evidence of tonsillar ectopia on brain MRI.

Results Eleven of these 144 patients (7.6%) had tonsillar ectopia and in eight patients (5.6%) the tonsils were located at greater than 5 mm below the foramen magnum. Four of these patients underwent posterior fossa decompressions and surgery was performed at a mean age of 3 years. Indications for surgery included severe behavioral problems and headaches in two patients and failure to thrive with severe breathing and feeding difficulties in two infants. All four improved after surgery. The other patients remained asymptomatic from their tonsillar ectopia, showed no signs of clinical or radiological progression, and did not require surgery.

Conclusions Chiari 1 malformation is more common in FG syndrome than in the general population. Not all patients require decompression and the decision to operate may be difficult because of FG syndrome patients' developmental delay, difficulties with language skills, general fatigue, possibilty of upper motor neuron dysfunction, behavioral problems, or failure to thrive, which may mask the symptoms of a symptomatic Chiari 1 malformation.

## 106. CORPUS CALLOSOTOMY FOLLOWING IMPLANTATION OF A VAGAL NERVE STIMULATOR FOR CONTROL OF INTRACTABLE EPILEPSY

*P. Daniel McNeely, MD, FRCS(C) (Halifax, NS, Canada); Jean-Pierre Farmer, MD FRCS(C); Jose L. Montes, MD, FACS; Bernard Rosenblatt, MD (Montreal, PQ, Canada)*

Introduction Corpus callosotomy and vagal nerve stimulation are treatment options available to patients with non-lesional, generalized epilepsy that is refractory to medical therapy. Patients who have previously undergone corpus callosotomy have been implanted with vagal nerve stimulators with some success. To our knowledge, the strategy of implanting a vagal nerve stimulator as the first surgical intervention, followed by anterior corpus callosotomy in patients who fail to achieve a satisfactory seizure control has never been reported.

Methods Two cases of corpus callosotomy following implantation of a vagal nerve stimulator are reported. Technical details of the cases are discussed.

Results Two patients treated at our center underwent implantation of a vagal nerve stimulator. Due to less than satisfactory control of atonic seizures, each of these patients subsequently underwent an anterior corpus callosotomy. Both patients had a complete relief of their atonic seizures, and a marked reduction in their overall seizure frequency.

Conclusions In view of its lesser morbidity, we recommend vagal nerve stimulation be performed prior to corpus callosotomy in patients who could be considered candidates for either procedure. Both of these surgical interventions may be considered complimentary to one another with the vagal nerve stimulator having some degree of efficacy with many different seizure types. Patients who continue to experience frequent atonic seizures following an adequate trial of vagal nerve stimulation should be considered candidates for corpus callosotomy.



## 107. CORRECTION OF SAGITTAL CRANIOSYNOSTOSIS USING A BILATERAL "TRAP-DOOR" SURGICAL TECHNIQUE: A TEN YEAR REVIEW

**Kenneth Shulman Award Candidate**

*Christian W. Sikorski, MD; Lawrence Iteld, MD; Bakhtiar Yamini, MD; Daniel J. Curry, MD; McKay McKinnon, MD; David M. Frim, MD, PhD (Chicago, IL)*

Introduction Multiple methods have been described for the correction of sagittal synostosis. The literature insufficiently documents the morbidity and recurrence rate associated with most of these techniques. We describe a modified surgical technique that includes: complete resection of the closed suture, reshaping of cut bones and creation of a bilateral "trap-door" mechanism that allows for unimpeded transverse brain growth. The results of 22 consecutive patients that underwent this procedure at our institution are presented.

Methods We reviewed 22 consecutive cases of sagittal craniosynostosis corrected with this technique. Most patients underwent surgery during infancy and follow-up for all cases is over six months. Clinical examination and computed tomography scans were used to compare preoperative and postoperative cranial indices.

Results All patients had postoperative normalization of their cranial index. There were no deaths and no patient required subsequent cranioplasty or device removal. No postoperative helmets were used for cranial shaping and average hospitalization was three days.

Conclusions Correction of sagittal craniosynostosis using this technique is safe and reliable. The construction of a "trap-door" mechanism can simplify the goal of restoring normal cranial shape.

## 108. TREATMENT OF PEDIATRIC CLIVAL CHORDOMAS

*Bryan C. Oh, MD; Mark D. Krieger, MD; J. Gordon McComb, MD (Los Angeles, CA)*

Introduction Clival chordomas are rare clinical entities with no commonly accepted standard treatment. There are even less data available for treatment of pediatric clival chordomas. Treatment strategies have included surgery alone or surgery followed by a combination of radiation and/or chemotherapy.

Methods An IRB-approved retrospective review of children treated with clival chordomas at our institution over the past decade was performed. Clinical histories, radiographic studies, and pathology results were all reviewed.

Results Six consecutively treated patients (three female, three male) were identified. The mean age at time of diagnosis was 8 years and ranged from 8 months to 19 years. The histologic diagnosis of chordoma was made independently by neuropathologists in every case. Three patients had surgery alone. Of these three, one presented with severe neurologic deficits that did not resolve after surgery. Although he had stable disease, he died 18 months after initial diagnosis from complications of pre-existing neurologic deficits. Two patients with staged surgical procedures have no disease progression with follow-up limited to six and eight months. The other three patients received chemotherapy consisting of ifosamide and etoposide after surgical debulking. All three of these patients had no evidence of disease progression at 3-5 years. Two of these patients are currently neurologically intact. The third patient had multiple residual signs of brainstem dysfunction.

Conclusions This limited series shows that judicious use of surgery and ifoasmide/etoposide chemotherapy can control progression of clival chordomas in children.

## 111. AICARDI SYNDROME ASSOCIATED WITH ENCEPHALOCELE IN TWO PATIENTS

**Kenneth Shulman Award Candidate**

*Rebekah C. Austin, MD; R. Gray Weaver, Jr.; Steven S. Glazier (Winston-Salem, NC)*

Introduction Aicardi syndrome is a rare X-linked congenital disorder found in infants with involuntary flexor spasms, corpus callosum agenesis, and chorioretinal lacunar lesions. Recent case reports have extended these findings to include ependymal cysts, choroid plexus papillomas, optic disc colobomas, and various migrational abnormalities as well as cleft lip and palate and vertebral anomalies. These additions to the clinical diagnosis are important to recognize the full spectrum of Aicardi syndrome and provide more insight into the embryologic events which have yet to be fully understood.

Methods Two female neonatal patients were referred for consideration of encephalocele repair. Both pregnancies were unremarkable and the encephaloceles were discovered at birth. One infant had a midline frontonasal lesion whereas the other demonstrated a midline parieto-occipital lesion. Each patient had preoperative MRI demonstrating callosal agenesis and vermian hypoplasia. Both patients had ophthalmologic confirmation of typical retinal lesions of Aicardi syndrome. One patient had bilateral optic nerve colobomas. Both infants underwent uneventful encephalocele repair. The patients have been followed for 5 years. Both patients suffer from intractable seizures and cognitive development has been minimal.

Conclusions We present the novel association of encephalocele in two patients meeting clinical criteria for Aicardi syndrome. Smalled isolated encephaloceles do not generally portend a poor neurologic outcome, however those associated with other congenital malformations may warrant more cautious caregiver counselling. Brain MRIs and photographs of chorioretinal lacunae illustrate the characteristic findings in the presented cases.

# POSTER INDEX


109. Changes in Brainstem Auditory Evoked Potentials after Suboccipital Decompression in Arnold-Chiari Malformation

*Christopher Troup, MD; Bridget Fuhrmann, RN, BSN; Carlos Feltes, MD; Vassilious Dimopoulos, MD; Induk Chung, PhD; Angel N. Boev, BS (Macon, GA); Dustin Wright, BS; Philip Smothers, BS (Alpharetta, GA)*

110. Toxicity and Efficacy Study of Locally-Delivered Chemotherapy in a Novel Rat Model of Intramedullary Spinal Cord Tumors

Kenneth Shulman Award Candidate

*Gustavo Pradilla, MD; Gaurav Mavinkurve, BS; Federico G. Legnani, MD; Betty M. Tyler, MD; Neha Gosalia, BA; Jonathan Pindrik, BS; Alia Hdeib, BA; Carlos A. Bagley, MD; Henry Brem, MD; George Jallo, MD (Baltimore, MD)*

112. Endoscopic Management of Third Ventricular Arachnoid Cysts

*Theodore Spinks, MD; Tien Nguyen, MD; Mark Krieger, MD; Gordon McComb, MD (Los Angeles, CA)*

113. Simultaneous Endoscopic Third Ventriculostomy (ETV) and Biopsy of Intraventricular Brain Tumors: A Simplified Approach

*Kyle T. Chapple, MD; Mark M. Souweidane, MD, FACS (New York, NY)*

114. A Research-Oriented Database for Patients with Hydrocephalus

*Emily J. Draper, MS; Yandong Zhou, MS; James P. McAllister II, PhD (Detroit, MI); Martin U. Schuhmann, MD, PhD (Leipzig, Germany); Sandeep Sood, MD; Steven D. Ham, DO (Detroit, MI)*

115. MRI Findings in Erb's Palsy

Hydrocephalus Award Candidate

*Juan C. Alzate, MD; Daniel Lefton; Rick Abbott, MD (New York, NY)*

116. A Novel Technique Involving Simultaneous Image-Guided and Endoscopic Surgical Navigation Without Rigid Skull Fixation in Infants

*Francesco T. Mangano, DO; Jeffrey R. Leonard, MD; T. S. Park, MD; Matthew D. Smyth, MD (St Louis, MO)*

117. Patterns of Recurrence in Surgically Resected Intracranial Ependymomas in Children

*Chris Heller, MD; Mark D. Krieger, MD; Ira Bowen, BS; J. Gordon McComb, MD (Los Angeles, CA)*

118. Implications of the Antenatal Diagnosis of Vertebral Body Anomalies in Patients Without Spinal Dysraphism

*John Thorne, MD; Jerard Ross; Carys Bannister; Sarah Russell; Ana Bonell (Manchester, United Kingdom)*

119. Are Programmable Shunt Valves as Reliable as Non-Programmable? Our Experience With the First Ninety-Two Valves Implanted

*Francesco T. Mangano, DO; Jose A. Menendez, MD; Prithvi Narayan, MD; Jeffrey R. Leonard, MD; T. S. Park, MD; Matthew D. Smyth, MD (St Louis, MO)*

120. Decompressive Hemicraniectomy for Non-Traumatic Pediatric Mass Lesions

*David Sacco, MD; Dale Swift; Brad Weprin; Angela Price; Fred Sklar (Dallas, TX)*

121. Outcome Following Multiple Topectomies in Children with Intractable Epilepsy and Radiographically Normal Epileptogenic Tissue

*Julian A. Mattiello, MD, PhD; Gregory W. Faris, BS; Dianna M. E. Bardo, MD; Kurt Hecox, MD, PhD; Michael Kohrman, MD; Charles Marcuccilli, MD, PhD; David M. Frim, MD, PhD, (Chicago, IL)*



122. Salvaging the "Lost" Peritoneum after Ventriculoatrial Shunt Failure

*R. Rick Bhasin, MD; Mike Chen, MD; David W. Pincus, MD (Gainesville, FL)*

123. Ventriculo-Peritoneal Shunt Complication Rates Post Abdominal Surgery in Patients with Spina Bifida

*John Thorne, MD; Paul Leach, MD, DMSc; Malcolm Lewis; Joanne Shaw, AFRCS (Salford Manchester, United Kingdom)*

124. Brain Stem Stereotactic Biopsy in Children

*David W. Pincus, MD, PhD; Anthony Yachnis, MD; Amy Smith, MD (Gainesville, FL)*

125. Are Magnetice Resonance Scan Findings Predictive of Bladder and Bowel Dysfunction in Spina Bifida Occulta

*John A. Thorne, MD; Paul Leach, MD; Joanne Shaw; Malcolm Lewis, MD (Manchester, United Kingdom)*

126. Referred Shoulder Pain from Ventriculoperitoneal Shunts

*James W. Custis, Jr., MD; R. Shane Tubbs, PhD; John C. Wellons, MD; Jeffrey P. Blount, MD; Paul A. Grabb, MD; W. Jerry Oakes, MD (Birmingham, AL)*

127. Patterns of Tumor Progression and Recurrence in Pediatric Pilocytic Astrocytoma

Jonathan Liang, BS; J. Gordon McComb, MD; Ira E. Bowen, BA; Mark D. Krieger, MD (Los Angeles, CA)

128. Clinical Characteristics of Spina Bifida Patients Requiring Surgery for Tethered Cord

*Muralidhara R. Raju, MD; Satish Krishnamurthy, MD; Nienke Dosa, MD, MPH (Syracuse, NY)*

129. A Novel Model of Primary Spinal Cord Tumors in Rabbits: Functional, Radiological and Histopathological Characterization

*Gustavo Pradilla, MD; Gaurav Mavinkurve, BS; Federico G. Legnani, MD; Betty M. Tyler, BA; Neha Gosalia, BA; Jonathan Pindrik, BS; Alia Hdeib, BA; Carlos M. Bagley, MD; Henry Brem, MD; George Jallo, MD (Baltimore, MD)*

130. A Novel Rat Model for Intramedullary Spinal Cord Glioma

*Gaurev Mavinkurve, BA; Gustavo Pradilla, MD; Federico G. Legnani, MD; Betty M. Tyler, BA; Neha Gosalia, BA; Jonathan Pindrik, BS; Alia Hdeib, BA; Carlos M. Bagley, MD; Henry Brem, MD; George Jallo, MD (Baltimore, MD)*

131. Corpus Callosotomy: An Old Therapeutic Technique as a New Diagnostic Approach to Identifying Resectable Epileptogenic Foci

*James E. Baumgartner, MD (Houston, TX)*

132. Primary Progressive Tonsillar Herniation In Chiari I Malformation

*Timothy M. George, MD (Durham, NC)*

133. SLO: The Application In Detecting Increased Intracranial Pressure

*Jeffrey E. Catrambone, Sr., MD; Charles J. Prestigiacomo, MD; Wenzhaun He (Newark, NJ)*

134. Meningiomas in Children

*Stephanie Greene, MD; Chong C. Lee, MD, PhD; Jeffrey G. Ojemann, MD; Richard G. Ellenbogen, MD; Anthony M. Avellino, MD, (Seattle, WA)*

135. Subaxial Cervical Stenosis With Myelopathy in Children With Achondroplasia: Case Report

*John K. Houten, MD; David Gordon, MD; James T. Goodrich, MD, PhD (Bronx, NY)*

136. Cytotoxicity and In Vivo Safety of Carboplatin and Minocycline for the Treatment of Malignant Gliomas

*Grettel J. Zamora-Berridi, BA; Federico G. Legnani, MD; Gustavo Pradilla, MD; Samuel Hertig, BA; Betty M. Tyler, BA; Henry Brem; Alessandro Olivi (Baltimore, MD)*

137. Posterior Lumbar Interbody Fusion Utilizing Allograft in Children: A Report of Two Cases

*Josh Miller, MD; Scott W. Elton, MD (Columbus, OH)*

138. Implantation of an Additional Gravitational Unit in Shunted Pediatric Hydrocephalus Patients With Overdrainage Syndrome

*Martina Messing-Juenger, MD; Jasmin Djawaheri-Eisenach, MD (Dusseldorf, Germany)*

139. Transient Ventriculoperitoneal Shunt Dysfunction in Myelodisplastic Children With Urinary Bladder Infection

*James W. Custis, Jr., MD; R. Shane Tubbs, PhD; John C. Wellons III, MD; Jeffrey P. Blount, MD; W. Jerry Oakes, MD, (Birmingham, AL)*

140. Failure Patterns and Long Term Outcome in Pediatric Patients Treated for Craniopharyngioma

*Jeffrey R. Leonard, MD; Lilie Lin, MD; David Mansur, MD (St. Louis, MO)*

141. Six Years Experience with the First Gravitational Shunt for Children: The PAEDI-GAV

*Regina Eymann, MD; Michael Kiefer, MD (Homburg-Saar, Germany)*

# POSTER ABSTRACTS

## 109. CHANGES IN BRAINSTEM AUDITORY EVOKED POTENTIALS AFTER SUBOCCIPITAL DECOMPRESSION IN ARNOLD-CHIARI MALFORMATION

*Christopher Troup, MD; Bridget Fuhrmann, RN, BSN; Carlos Feltes, MD; Vassilious Dimopoulos, MD; Induk Chung, PhD; Angel N. Boev, BS (Macon, GA); Dustin Wright, BS; Philip Smothers, BS (Alpharetta, GA)*

Introduction We investigated the use of brainstem auditory evoked potential (BAEP) intra-operative monitoring in suboccipital decompression (SOD) for Arnold-Chiari malformations (ACM). We recorded BAEPs intraoperatively at different surgical steps: before skin incision and immediately after bony decompression, release of dural band, opening the dura mater, and duraplasty.

Methods Prospective analysis of eight patients (age range 4~ 40, six females, two males, mean age 20.0 years) undergoing suboccipital decompression for treatment of symptomatic Chiari I malformation. Intraoperative monitoring of BAEPs and somatosensory evoked potentials (SSEPs) was performed. Latencies and amplitudes of the obligatory peaks of BAEPs (I, III, V) and SSEPs (P37, N45) were recorded. For BAEPs, interpeak latencies (IPLs) of peak I to V were also recorded from the obligatory peaks.

Conclusions Our results indicate that significant improvement in conduction of the brain stem occurs after bony decompression with duraplasty in ACM. Even with normal baseline BAEPs, significant improvement of brainstem conduction is observed during SOD for ACM. The greatest improvement was most often observed with duraplasty, however. BAEP monitoring can aide in tailored decompression as well.

## 110. TOXICITY AND EFFICACY STUDY OF LOCALLY-DELIVERED CHEMOTHERAPY IN A NOVEL RAT MODEL OF INTRAMEDULLARY SPINAL CORD TUMORS

**Kenneth Shulman Award Candidate**

*Gustavo Pradilla, MD; Gaurav Mavinkurve, BS; Federico G. Legnani, MD; Betty M. Tyler, MD; Neha Gosalia, BA; Jonathan Pindrik, BS; Alia Hdeib, BA; Carlos A. Bagley, MD; Henry Brem, MD; George Jallo, MD (Baltimore, MD)*

Introduction Intramedullary spinal cord tumors (IMSCTs) are associated with significant morbidity/mortality and current treatment strategies for IMSCTs remain limited. Systemic chemotherapy has been unsuccessful for these tumors. Recent advances in local-drug-delivery systems make them ideal for IMSCTs. We report the toxicity of novel injectable chemotherapy-delivery systems Oncogel®(Taxol gel), SABER®(Carboplatin gel), and Paclimer®(Taxol-microspheres) in rat's spinal cord, and the efficacy of Oncogel-1.5% in an IMSCT model using 9L-gliosarcoma in rats.

Methods Toxicity: Fischer-344 rats (n=21) were randomized into seven groups (3 rats/group) to receive an intramedullary injection (IMI) of either ReGel (empty gel), Oncogel-1.5%, Oncogel-6%, Saber-15%, Paclimer-2mg/kg, Paclimer-20mg/kg, or DMEM (Dulbecco's-modified-eagle-medium). Daily evaluation of hind limb motor function (using the BBB-Basso-Beattie-Bresnahan-scale) and weight gain were analyzed. Efficacy: Fischer-344 rats (n=12) were randomized into 3 groups (4/group), group one received an IMI of 9L cells, groups two and three received an IMI of 9L, plus Oncogel-1.5% or ReGel, respectively; animals were assessed daily using the BBB scale.

Results Toxicity: Animals treated with Oncogel-6% showed acute toxicity (one animal died on day four, three animals were euthanized due to complete paraplegia on day five), animals in other groups showed weight gain and maximal BBB scores throughout the experiment. Efficacy: group one (controls) had median onset of paralysis (MOP) of 10 days, group two (Oncogel-1.5%) had no significant motor deficit by day 20, Group three (ReGel) had MOP of 14±1.4 days.

Conclusions Locally-delivered chemotherapy, with the exception of Oncogel-6%, was well tolerated by the animals. Oncogel-1.5% significantly prolonged onset of paralysis. Further studies are needed to determine the efficacy of SABER and Paclimer for IMSCTs.

## 112. ENDOSCOPIC MANAGEMENT OF THIRD VENTRICULAR ARACHNOID CYSTS

*Theodore Spinks, MD; Tien Nguyen, MD; Mark Krieger, MD; Gordon McComb, MD (Los Angeles, CA)*

Introduction Arachnoid cysts within the third ventricle are rare and can manifest as mental status changes and hydrocephalus if there is obstruction of cerebrospinal fluid (CSF) flow. In this report, the authors evaluate the efficacy of neuroendoscopy in the treatment of children with symptomatic third ventricular arachnoid cysts.

Methods A retrospective analysis of children with arachnoid cysts located within the third ventricle treated by endoscopic cystoventriculostomy between 1999 and 2002.

Results Six children, four of them boys, were identified. The median age at the time of surgery was 4 years. Signs and symptoms included headache, progressive increase in the size of cyst and/or lateral ventricles, and mental status changes. Two children had ventriculoperitoneal shunts inserted 10 and 23 months prior but had recurrence of symptoms of hydrocephalus. Their shunts were removed during the endoscopic surgery. Even though third ventriculostomy was attempted in all the children after fenestration of the cyst, in only two was it completed. Median follow-up time was 39 months (range 19-42 months). All patients had improvement of symptoms and significant reduction in cyst volume and at least marginal decrease in the size of the lateral ventricles on follow-up scans. One of the two children who also had third ventriculostomy had CSF leak after the operation and developed meningitis. After a course of antibiotics, a ventriculoperitoneal shunt was placed.

Conclusions Endoscopic fenestration and third ventriculostomy is an effective primary treatment of third ventricular arachnoid cysts. Satisfactory long-term decompression of the cyst and restoration of normal CSF circulation can be obtained.

## 113. SIMULTANEOUS ENDOSCOPIC THIRD VENTRICULOSTOMY (ETV) AND BIOPSY OF INTRAVENTRICULAR BRAIN TUMORS: A SIMPLIFIED APPROACH

*Kyle T. Chapple, MD; Mark M. Souweidane, MD, FACS (New York, NY)*

Introduction Endoscopic management of patients with hydrocephalus and a posterior third ventricular or pineal region tumor is well established. However, given the multiple goals of surgery, each optimized by a different trajectory, alternative methods have advocated the use of flexible endoscopes or multiple entry sites. A technique using a single entry site with a rigid endoscope is reviewed.

Methods Patients undergoing endoscopic management of hydrocephalus and a posterior third ventricular tumor were reviewed. Fourteen patients with ages ranging from 2 to 59 years (mean 23.9 years) are included. Conventional landmarks were used to access the ventricular compartment through a single, right-precoronal burr hole. Stereotaxis was used as a navigational adjunct in four patients. A 00 degree lens was primarily used for the ETV and a 300 angled lens directed posteriorly was used for the tumor biopsy. The surgical method, the intended goal, and patient outcome are reviewed.

Results Successful ETV and diagnostic biopsy were accomplished in all patients. ETV preceded tumor biopsy in all cases. Three patients had an externalized drain placed at the time of the procedure for pressure monitoring. No patient had recognized intracerebral hemorrhage. One subject suffered a diencephalic syndrome and required a ventriculoperitoneal shunt due to continued elevated pressures.

Conclusions Use of an interchangeable-solid lens endoscope through a single burr hole is safe and effective for simultaneous ventriculocisternotomy and tumor biopsy. This simplified method avoids the inferior resolution of stearable, fiberoptic endoscopes and the purported need for multiple burr holes.

## 114. A RESEARCH-ORIENTED DATABASE FOR PATIENTS WITH HYDROCEPHALUS

*Emily J. Draper, MS; Yandong Zhou,MS; James P. McAllister II, PhD (Detroit, MI); Martin U. Schuhmann, MD, PhD (Leipzig, Germany); Sandeep Sood, MD; Steven D. Ham, DO (Detroit, MI)*

Introduction To overcome the limitations of current patient databases as a research tool, especially for hydrocephalus studies, we have developed a comprehensive program and tested it at the Children's Hospital of Michigan.

Methods The database was built using Oracle Database and Oracle Developer software for a Windows platform.

Results Patient information is compiled from the hospital's electronic systems (text and images) office charts, and hospital medical records, and organized onto the patient's main page, including demographical information, admission dates, and the main and admitting diagnoses. Based on a particular admission date, a single click can locate admission details such as operative reports, radiology reports and images, laboratory results, and complications. The most important aspect of this database is its capability to run detailed searches. One may perform a search with criteria such as "male" and "obstructive hydrocephalus," then narrow the results by entering parameters such as "PS Medical valve" and "blood culture Staphylococcus epidermidis." Search results can be graphed in Oracle and/or exported to Microsoft Excel and statistical programs. The time needed for data entry varies according to the degree of complications: a two-day hospital stay with one shunt revision requires only about 15 minutes, while a complicated course of 20 shunt revisions per year requires about three hours. It takes only 10 minutes to update patients already in the database, so tracking and following active patients is expeditious once the baseline data have been entered.

Conclusions This database will allow comprehensive, multicenter research to promote better treatments for hydrocephalus.

## 115. MRI FINDINGS IN ERB'S PALSY

**Hydrocephalus Award Candidate**

*Juan C. Alzate, MD; Daniel Lefton; Rick Abbott, MD (New York, NY)*

Introduction We reviewed MR imaging in infants with Erb's palsy. The goal was to determine the effectiveness of MR imaging in predicting operative findings for these infants.

Methods Fifteen patients (mean age: 14.5 months) underwent brachial plexus exploration. The T1 and T2-weighted pre and post-operative MR images were analyzed and correlated to surgical findings as outlined in the children's operative notes.

Results Through imaging, the presence of at least one pseudomeningocele was found in eight of the 15 patients (53.3%) while three of the 15 patients (20%) had multiple pseudomeningoceles. Shoulder subluxation was seen in 11 patients (73.3%). Fourteen children (93.3%) had imaging abnormalities consistent with either a reparative neuroma or scar tissue investing plexus elements. We found differentiating between the two with MR imaging to be nearly impossible. At surgery, scar tissue was found entrapping the C5-6 roots, upper trunk and/or lateral and posterior cords in eleven patients (73.3%) while four patients had reparative neuromas. Two patients had both entrapment by scar tissue and a reparative neuroma. Either entrapment by scar tissue or neuroma was found in all 15 patients (100%).

Conclusions MR imaging is an effective tool for demonstrating lesions of the brachial plexus worthy of surgical exploration.

## 116. A NOVEL TECHNIQUE INVOLVING SIMULTANEOUS IMAGE-GUIDED AND ENDOSCOPIC SURGICAL NAVIGATION WITHOUT RIGID SKULL FIXATION IN INFANTS

*Francesco T. Mangano, DO; Jeffrey R. Leonard, MD; T. S. Park, MD; Matthew D. Smyth, MD (St Louis, MO)*

Introduction We describe a novel application that allows for minimally invasive management of complex arachnoid cysts and intra/periventricular lesions by merging endoscopic and stereotactic technology without the need for rigid skull fixation.

Methods A dynamic reference frame (Stealth AxiEM, Medtronic, Louisville CO) is used to register patients for stereotactic image guidance without rigid skull fixation. The navigation software is used to plan a trajectory for gaining entry into the ventricles or cyst, and also allows for fenestration. This trajectory is used for insertion of a rigid endoscope (Aesculap, Germany) for direct visualization. After achieving endoscopic visualization, the AxiEM single coil is inserted into the endoscopic port. It is then used to stereotactically track its position and identify areas for fenestration and/or catheter insertion. The application of these technologies simultaneously allows for both image guided and direct visualization of the intracranial anatomy.

Results We did not detect interference from the metallic components of the endoscope affecting the ability of the EM-based Stealth AxiEM system to track the stylet/pointer. Advantages of this technique include the ability to perform the procedure without pinning the head, and if necessary, to change the head position during the procedure without losing stereotactic capability. Additionally one can distinguish the pertinent anatomy in real time on both image guided and endoscopic systems.

Conclusions Endoscopic views alone are often difficult to interpret in complex or massive arachnoid cysts. This technique may prove to be advantageous when managing cases of complex hydrocephalus and arachnoid cysts, as well as biopsy of intra/periventricular lesions in infants.

## 117. PATTERNS OF RECURRENCE IN SURGICALLY RESECTED INTRACRANIAL EPENDYMOMAS IN CHILDREN

*Chris Heller, MD; Mark D. Krieger, MD; Ira Bowen, BS; J. Gordon McComb, MD (Los Angeles, CA)*

Introduction Intracranial ependymomas are among the most challenging pediatric brain tumors to effectively and safely treat. Although complete surgical resection is the goal, the proximity of these tumors to vital brainstem structures often precludes such. Even with gross total resection, with or without adjuvant therapy, recurrence occurs.

Methods We retrospectively reviewed 30 children who underwent surgical resection of intracranial ependymomas at our institution from 1988 to 2003. Time to recurrence, if any, was calculated and correlated to extent of resection and tumor histology.

Results There was tumor recurrence following surgical resection in 10 of 30 (33%) patients, eight (80%) of whom had a gross total resection by post-operative MRI. Average time to recurrence was longer in patients who had gross total resection versus subtotal resection (26 months vs. 8 months p=0.01). There was no difference between patients with anaplastic vs. plain histological grade (20 months vs. 29 months p=0.35). 90% of recurrences occurred by 42 months after surgery with the latest recurrence at 48 months. In all but one patient the time to recurrence obeyed Collins' Law. In seven of ten cases the recurrence was discovered by surveillance MRI while three patients developed new signs or symptoms prompting imaging.

Conclusions Tumor recurrence is common even after gross total resection. Time to recurrence is significantly shorter with subtotal resection, but is not affected by tumor histology. Time to recurrence follows Collins' Law in most instances. Serial imaging is a necessary and important part of post-operative care following resection of an ependymoma.

## 118. IMPLICATIONS OF THE ANTENATAL DIAGNOSIS OF VERTEBRAL BODY ANOMALIES IN PATIENTS WITHOUT SPINAL DYSRAPHISM

*John Thorne, MD; Jerard Ross; Carys Bannister; Sarah Russell; Ana Bonell, Manchester (United Kingdom)*

Introduction Vertebral body anomalies are detectable in the foetus by ultrasonography at 18-20 weeks gestation. The anomalies encountered are a heterogeneous group, and an understanding of the different prognoses is important, so that both clinicians and parents are prepared for the potential problems.

Methods Data was collected from records kept of the foetal anomalies found on routine scanning. The proforma identifies the anatomical site of all anomalies. From this data it was possible to elicit which were the patients with spinal anomalies. The scan reports were then obtained and examined and only those with vertebral body anomalies were included in the report. Those with meningocoele, myelomeningocoele, spinal dysraphism, diastem, caudal regression and limb-body wall complex were all excluded. The ultrasound scans, the reports and any follow up data were recorded.

Results Eighty-eight cases were found. Twenty-five had isolated vertebral anomalies and the rest complicated. Of the 25 with isolated anomalies, 20 delivered normally, one died in utero, one pregnancy was terminated and outcome data was not available for three. Of the 63 with complicated anomalies, 25 delivered normally of whom seven died in the neonatal period, 33 pregnancies were terminated, two died in utero and three were stillborn. Of the 20 children with isolated anomalies born normally three have required surgery for spinal deformity. All these have had abnormalities in their lumbar spine.

Conclusions An isolated vertebral anomaly discovered in utero carries with it at least a 15% risk of significant spinal curvature in childhood.



## 119. ARE PROGRAMMABLE SHUNT VALVES AS RELIABLE AS NON-PROGRAMMABLE? OUR EXPERIENCE WITH THE FIRST NINETY-TWO VALVES IMPLANTED

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Introduction The use of adjustable differential pressure valves with a syphon-preventing device (Strata Valve, Medtronic) has improved shunt performance when properly indicated. Its efficacy has been documented previously, however, there is no data available regarding its reliability in clinical use.

Methods A retrospective analysis of the charts of all 92 programmable valves implanted in our institution from April 2002 to June 2004 was performed. Regular follow-up occured on all patients ranging from one to 26 months, with a mean and median follow-up time of 9.75, and nine months respectively.

Results Patients ranged from two weeks to sixteen years of age. Eighty-one patients had 92 programmable valves implanted. Fifty-nine patients had no complications from their programmable csf shunt devices, and 19 patients underwent revision due to malfunction. Three additional patients had their shunt system removed after successful endoscopic third ventriculostomy. The programmable valve itself malfunctioned in seven of the 19 patients undergoing revisions, as documented by failure to open at an expected pressure by manometer testing. Of the remaining 12 patients, two developed infections, eight required proximal revisions and two required a distal revision over the 26 month period.

Conclusions The use of adjustable valves has improved shunt performance in selected indications. The reported rate of valve malfunction for programmable systems is 2%, in comparison, our experience demonstrates a rate of 10.6% per year. Further evaluation must be undertaken with a greater number of treated cases to better determine the reliability and failure rate.

## 120. DECOMPRESSIVE HEMICRANIECTOMY FOR NON-TRAUMATIC PEDIATRIC MASS LESIONS

*David Sacco, MD; Dale Swift, MD; Brad Weprin; Angela Price; Fred Sklar (Dallas, TX)*

Introduction Decompressive hemicraniectomy has become an accepted adjunct to management of mass effect in adults. We present our experience with decompressive hemicraniectomy for non-traumatic pediatric mass lesions to further define the indications, outcome and potential complications of this procedure in the pediatric population.

Methods A retrospective review of the patients from a single pediatric neurosurgical practice (Neurosurgeons for Children) over a 13 month period revealed five patients undergoing decompressive hemicraniectomy for non-traumatic mass lesions. These histories, imaging studies, procedures and outcomes were evaluated and reported.

Results Five patients underwent decompressive hemicraniectomy. The patients ages ranged from 6 to 15 (mean 9.8 ) years. The etiology of the mass lesion was ischemic infarct (2), intracerebral hemorrhage (2), subdural empyema and cerebritis (1). All patients had the craniectomy flap stored in a subcutaneous abdominal pocket. All patients improved significantly but were left with focal deficits related to their original event. Cranioplasty has been performed with the previously removed bone graft in 4/5 (80%) at a range of 2-5 (mean 3) months. There were no complications related to subcutaneous placement of the bone. One patient developed a wound infection two weeks s/p cranioplasty.

Conclusions Decompressive hemicraniectomy is a useful procedure to manage mass effect from a variety of non-traumatic mass lesions in the pediatric population. Patients can survive and improve to be functionally independent. Storage of the bone in a subcutaneous abdominal pocket is safe and well tolerated. Decompressive hemicraniectomy should be considered for non-traumatic mass lesions in the pediatric population.

## 121. OUTCOME FOLLOWING MULTIPLE TOPECTOMIES IN CHILDREN WITH INTRACTABLE EPILEPSY AND RADIOGRAPHICALLY NORMAL EPILEPTOGENIC TISSUE

*Julian A. Mattiello, MD, PhD; Gregory W. Faris, BS; Dianna M. E. Bardo, MD; Kurt Hecox, MD, PhD; Michael Kohrman, MD; Charles Marcuccilli, MD, PhD; David M. Frim, MD, PhD, (Chicago, IL)*

Introduction For children with intractable epilepsy, identification of more than one seizure focus is considered a contraindication to surgical resection. We present a series of patients with intractable epilepsy in whom two non-adjacent independent epileptogenic foci were resected.

Methods Evaluation included imaging, electroencephalography and electrocorticography. Imaging and spectroscopy data (including magnetic resonance, positron emission topography, and mass spectroscopy) did not yield information that could be used to discriminate epileptogenic from electrically normal tissue. Scalp electrodes provided regional data of abnormal electrical activity. Following surgical placement of cortical grids and strip electrodes, the data obtained during continuous video-electroencephalograhic recordings were used to identify two independent, spatially discrete seizure foci.

Results In all cases, non-adjacent topectomies were performed in two lobes during a single operation. Surgical pathology identified abnormal cortical histology/organization within the resected tissues in all but one patient. Post-operative outcome data (average interval = 14 months) demonstrate that no patient experienced any new neurologic deficit (0%). One patient had no change (20%), and one patient had an increase in seizure activity (20%). Three patients (60%) were found to have a decrease in seizure severity or frequency. There was one mortality associated with a nosocomial systemic infection (20%). One patient (20%) was able to attend school after surgery.

Conclusions Extrapolation of our results suggest that there may be a subpopulation of those children who are at risk for progressive neurologic debilitation secondary to refractory seizures that may benefit from aggressive intervention including invasive electrocorticography and (when necessary) multiple topectomies.

## 122. SALVAGING THE "LOST" PERITONEUM AFTER VENTRICULOATRIAL SHUNT FAILURE

*R. Rick Bhasin, MD; Mike Chen, MD; David W. Pincus, MD (Gainesville, FL)*

Introduction Ventriculoperitoneal (VP) shunting remains the treatment of choice for the majority of pediatric patients with communicating hydrocephalus. For patients who have repeat distal failures or recent peritonitis, ventriculoatrial (VA) shunting is often the next choice. However, VA shunts may be complicated by venous thrombosis, distal failure from fibrin sheaths, bacteremia and rarely, endocarditis. When VA shunts fail, options include VA shunt revision, shunting to the pleural space, gallbladder or urological sites. Each of these has technical difficulties as well as potential operative and postoperative complications. Since we feel that VP shunting remains the safest and least complicated method for the long-term management of communicating hydrocephalus, we have used a strategy of attempted peritoneal salvage in patients with histories of inhospitable peritoneal spaces.

Methods Between 2000 and 2003 at the University of Florida, six patients with chronic hydrocephalus were treated with VP shunts following failure of VA shunts. All patients had been found to have inappropriate peritoneal cavities for VP shunting by previous neurosurgeons due to infection or recurrent distal failures. In most cases, children underwent laparoscopy to salvage peritoneal spaces for CSF shunting. This was done with the assistance of a pediatric surgeon.

Conclusions The mean follow-up of 1.5 years reveals no evidence of shunt malfunction in this small group of patients. Converting back to a VP shunt following a VA shunt failure is possible if a suitable peritoneal pocket is found.

## 123. VENTRICULO-PERITONEAL SHUNT COMPLICATION RATES POST ABDOMINAL SURGERY IN PATIENTS WITH SPINA BIFIDA

*John Thorne, MD; Paul Leach, MD, DMSc; Malcolm Lewis; Joanne Shaw, AFRCS (Salford Manchester, United Kingdom)*

Introduction Shunt complications following abdominal surgery are well recognised. Because of the need for continence procedures patients with spina bifida often require laparotomies. We present the shunt complication rate in this group.

Methods From a regional prospectively collected spina bifida registry of 270 patients, those with ventriculoperitoneal shunts who had had abdominal surgery were identified. A case note review was then undertaken to establish the incidence of shunt complications. Type of surgery and cause of complication was recorded.

Results Fifty-seven abdominal procedures were performed in 39 patients. Nine patients had shunt dysfunction, requiring neurosurgical intervention, within three months of surgery. The overall risk of shunt malfunction was 15.8%.

Conclusions Shunt malfunction is common after major abdominal surgery in patients with spina bifida. Patients and their families need to be counselled appropriately prior to surgery. Abdominal surgery in patients with spina bifida and hydrocephalus should be carried out in units with neurosurgery onsite.

## 124. BRAIN STEM STEREOTACTIC BIOPSY IN CHILDREN

*David W. Pincus, MD, PhD; Anthony Yachnis, MD; Amy Smith, MD (Gainesville, FL)*

Introduction While it is widely accepted that biopsy is not indicated for the diagnosis and emperic treatment of diffuse pontine glioma it is not unusual to encounter patients with brain stem lesions that cannot be diagnosed on the basis of imaging studies only. In many of these cases, a tissue diagnosis is necessary to make appropriate treatment recommendations.

Methods We retrospectively reviewed our institutional experience with stereotactic biopsy in pediatric patients over a three year period. Nine patients underwent biopsy of brainstem lesions using a three-dimensional graphics workstation for trajectory planning.

Results Two patients experienced mild diplopia postoperatively. No other morbidity and no mortality was noted. Pathologic diagnoses included low grade astrocytoma (three), glioblastoma (one classic and one giant cell variant), recurrent medulloblastoma, and demyelination. Two extremely unusual histologies, atypical neurocytoma and microglial tumor, were also encountered.

Conclusions This small series suggests that brainstem stereotactic biopsy in children is a safe procedure with high diagnostic yield. The finding of varied diagnoses indicates that when the radiographic findings are not consistent with diffuse pontine glioma, stereotactic biopsy should be considered.

## 125. ARE MAGNETIC RESONANCE SCAN FINDINGS PREDICTIVE OF BLADDER AND BOWEL DYSFUNCTION IN SPINA BIFIDA OCCULTA

*John A. Thorne, MD; Paul Leach, MD; Joanne Shaw; Malcolm Lewis, MD (Manchester, United Kingdom)*

Introduction To assess the risk of bladder and bowel neuropathy in spina bifida occulta patients

Methods The magnetic resonance images of 69 patients (43 females, 26 males) between the ages of 3 and 62 (median age 10.5yrs) were reviewed. From MR findings three groups were identified. Group one had sacral agenesis / hypoplasia or evidence of caudal regression. Group two had a meningocele or lipomyelomeningocele but no features of group 1. Group three had other lesions.

Results Thirty-five (50.7%) had a neuropathic bladder and bowel. Twenty-two (31.9%) had lower limb neurological abnormalities but only 11 of these had bowel and bladder neuropathy. The risk of bladder and bowel neuropathy was significantly greater in Group one patients. Of 17 patients in group one, 15 (88%) had bladder and bowel neuropathy, compared to nine of 14 in group two (64%) and 11 of 38 (29%) in group three (Group one vs Groups two and three, $p = 0.0005$ group one vs group three, $p < 0.0001$, group two vs group three, $p = 0.0276$). For those in Group three there was no relationship between MR findings (long/tethered cord, lipoma, diastem and split cord or syringomyelia) and the presence of bladder and bowel neuropathy.

Conclusions This data is important information for antenatal and postnatal counselling. It may also help guide the investigation and management of these patients. The low rate of bladder and bowel neuropathy in Group 3 patients raises a questionmark over the role of prophylactic surgery in this group.

## 126. REFERRED SHOULDER PAIN FROM VENTRICULOPERITONEAL SHUNTS

*James W. Custis, Jr., MD; R. Shane Tubbs, PhD; John C. Wellons, MD; Jeffrey P. Blount, MD; Paul A. Grabb, MD; W. Jerry Oakes, MD (Birmingham, AL)*

Introduction Three pediatric patients with ventriculoperitoneal shunts who presented with chronic right shoulder pain had imaging that revealed the distal peritoneal catheter was positioned between the right hemidiaphragm and liver. Following surgical repositioning of the distal tubing, all patients had resolution of their shoulder pain that has not returned.

Methods The clinical history and imaging data of three patients were reviewed. Each patient presented with right shoulder pain.

Conclusions Although seemingly rare, referred shoulder pain from a ventriculoperitoneal shunt should be added to the list of complications seen with this method of cerebrospinal fluid diversion. The clinician who cares for patients with ventriculoperitoneal shunts may wish to evaluate cases of shoulder pain without obvious neural or musculoskeletal cause with imaging of the distal shunt tubing. The pain can be similar to and potentially mistaken for cholecystitis.

## 127. PATTERNS OF TUMOR PROGRESSION AND RECURRENCE IN PEDIATRIC PILOCYTIC ASTROCYTOMA

*Jonathan Liang, BS; J. Gordon McComb, MD; Ira E. Bowen, BA; Mark D. Krieger, MD (Los Angeles, CA)*

Introduction Pilocytic astrocytomas are associated with poorer prognosis depending on tumor location, resection, and recurrence. Understanding patterns of recurrence would increase vigilance where indicated, and patient reassurance where indicated.

Methods A 10 year series of consecutive patients treated at one institution was analyzed retrospectively with IRB approval. The patients' medical records were reviewed in their entirety. All histological diagnoses were confirmed on blinded review. Forty-nine patients were diagnosed with pilocytic astrocytomas from January 1994 to January 2004. There were 25 (51%) male and 24 (49%) female patients. The average age at diagnosis was 8.0 years, and the average follow-up was 3.7 years. Thirty-one (63%) patients underwent gross total resection (GTR) by both surgical and radiographic reports, and 18 (37%) underwent sub-total resection or biopsy (STR).

Results 6 (12%) patients had recurrent disease with GTR, and 10 (20%) patients had progressive disease with STR. Time to recurrence was 2.33 years for patients with GTR, and 0.74 years to progression for patients with STR ($p=0.04$). 87.5% of the progressions were detected by surveillance scanning, while 12.5% were detected by new symptoms which prompted an imaging study. Age, sex, presentation, and tumor location did not affect time to progression. All progressions occurred within the period predicted by Collins Law, and 13/16 occurred within 2 years.

Conclusions Recurrent or progressive disease is predicated by the degree of surgical resection. GTR confers a longer event-free survival than STR. Recurrence or progression typically occurs within two years, which should be the period of heightened vigilance. Surveillance scanning is beneficial in following these patients.

## 128. CLINICAL CHARACTERISTICS OF SPINA BIFIDA PATIENTS REQUIRING SURGERY FOR TETHERED CORD

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Introduction Spina bifida (SB) is associated with many neurological abnormalities. Although the prevalence of tethered or low-lying spinal cords in SB is high, not everyone undergoes surgical correction of their tethered cords. We explored the functional status of SB patients with and without tethered cords requiring surgical correction (TCs), and the likelihood of having associated abnormalities including hydrocephalus and seizures.

Methods We performed a case control study of 219 patients followed in our SB clinic between 1980-2004. Patients' functional status was reported using the Functional Independence Measure (FIM). FIMs and body mass index (BMI) were analyzed using the t test. Prevalence of hydrocephalus and seizures were analyzed using the chi-square test.

Results Mean FIMs for patients with TCs was 103.52. Without TCs was 88.40. The means' difference was 15.12 points (95% CI: 7.573 - 22.667). For BMI, the respective means were 23.22 and 23.62 and means' difference was 0.394 (CI 2.413 - (-1.625)).

The odds ratio of having seizures was 0.584 (CI: 0.285 - 1.194) and of hydrocephalus requiring shunting, 0.188 (CI: 0.104 - 0.340), in patients with TCs versus those without TCs.

Conclusions There was no difference in the body mass index nor seizure prevalence between those SB patients requiring and not requiring surgery for TC. On the other hand, patients requiring TC surgery have a better functional score and have a reduced prevalence of shunted hydrocephalus. The improved functional status and reduced prevalence of hydrocephalus urge the clinician to actively seek symptoms of TC in SB patients to prevent permanent neurologic dysfunction.

## 129. A NOVEL MODEL OF PRIMARY SPINAL CORD TUMORS IN RABBITS: FUNCTIONAL, RADIOLOGICAL AND HISTOPATHOLOGICAL CHARACTERIZATION

*Gustavo Pradilla, MD; Gaurav Mavinkurve, BS; Federico G. Legnani, MD; Betty M. Tyler, BA; Neha Gosalia, BA; Jonathan Pindrik, BS; Alia Hdeib, BA; Carlos M. Bagley, MD; Henry Brem, MD; George Jallo, MD (Baltimore, MD)*

Introduction Intramedullary spinal cord tumors in children are often surgically incurable and current treatment options are limited. The creation of an animal model would be an asset for testing novel chemotherapeutic paradigms. We report the technique, functional progression, radiological appearance, and histopathological features of a novel intramedullary tumor model in rabbits.

Methods Ten New Zealand white rabbits were randomized into two experimental groups. Animals in group 1 received an intramedullary injection of 25 mcl of 2x107 cells/ml of VX2 adenocarcinoma. Rabbits in group 2 received an intramedullary injection of 25 mcl of Dulbecco modified Eagle medium. The animals were imaged with MRI pre-operatively and weekly after surgery until onset of hind limb paresis, at which point the rabbits were euthanized and spines were harvested for histopathological analysis.

Results Animals in group 1 had a statistically significant mean onset of paresis of 17±2 days (P=0.0035, Log-rank-test) after tumor implantation, compared to group 2 animals which lacked neurological deficits by day 45 post-injection. MRI confirmed space-occupying lesions, with acute ischemic cord changes in all animals implanted with VX2. Histopathological analysis revealed extensive invasion of the spinal cord with marked ischemia and necrosis. Control animals showed no significant radiological or pathological abnormalities.

Conclusions Clinical progression was consistent in all the VX2 injected animals, with paresis occurring 17±2 days after tumor injection. Histopathological and radiological characteristics of the intramedullary VX2 tumor are comparable to those of primary human spinal cord tumors. The establishment of this intramedullary tumor model will allow the testing of new treatment paradigms.

## 130. A NOVEL RAT MODEL FOR INTRAMEDULLARY SPINAL CORD GLIOMA

*Gaurev Mavinkurve, BA; Gustavo Pradilla, MD; Federico G. Legnani, MD; Betty M. Tyler, BA; Neha Gosalia, BA; Jonathan Pindrik, BS; Alia Hdeib, BA; Carlos M. Bagley, MD; Henry Brem, MD; George Jallo, MD (Baltimore, MD)*

Introduction The majority of pediatric intramedullary spinal cord tumors are of glial origin. However, the absence of an adequate animal intramedullary model has hindered the development of new treatment paradigms such as local-delivery of chemotherapeutic agents. In this study we describe the technique for intramedullary injection of an experimental glioma in rats and present the methodology for functional and histopathological analysis of tumor progression.

Methods Female Fischer-344 rats weighing 150-200 gms were anesthetized, a 2 cm incision was made in the dorsal mid-thoracic region, and the spinous process of two adjacent vertebrae were removed to expose the intervertebral space. The ligamentum flavum was removed and a 5mcl suspension containing 100,000 9L gliosarcoma cells was injected into the spinal cord. Control animals were injected with 5mcl of DMEM(Dulbecco's-modified-eagle-medium). Animals were evaluated daily for signs of paralysis and euthanized after onset of deficits for histopathological analysis.

Results Animals injected with 9L gliosarcoma developed bilateral hind limb paralysis on day 10 after injection. Animals injected with DMEM did not show neurological deficits. H&E cross sections confirmed the presence of intramedullary 9L tumors invading the spinal cord (Figure1). Control animals had no significant histopathological findings.

Conclusions Animals injected with 9L gliosarcoma cells consistently develop hind limb paresis 10 days after tumor injection. Histological characteristics of intramedullary 9L are comparable to those of intracranial 9L gliosarcoma, a widely accepted experimental model of intracranial gliomas. This model can be used for preclinical testing of novel local-delivery therapeutic agents.

## 131. CORPUS CALLOSOTOMY: AN OLD THERAPEUTIC TECHNIQUE AS A NEW DIAGNOSTIC APPROACH TO IDENTIFYING RESECTABLE EPILEPTOGENIC FOCI

*James E. Baumgartner, MD (Houston, TX)*

Introduction The corpus callosum is the principal anatomic and neurophysiologic tract linking the cerebral cortices. Neuronal signaling is transmitted across this vast network of axons to contralateral homotopic regions. Similarly, these tracts allow the spread of epileptiform discharges between hemispheres. In epilepsy, generation of secondarily geneleralized seizures is dependent on propagation of synchronous bilateral discharges. Interruption of signal transduction via this pathway can inhibit seizure generalization. Corpus callosotomy was developed to prevent epileptiform bisynchrony, particularly for seizures with rapid generalization. Typically these seizures lack localizing features of EEG and imaging studies. We describe five cases of intractable epilepsy whose focal features did not become apparent until corpus callosotomy was performed.

Methods Five patients with refractory epilepsy underwent phase one evaluation (including MRI, EEG, MEG and neuropsychological testing) which did not suggest focal seizure onset. All underwent corpus callosotomy, and repeat phase one evaluation post-callosotomy revealed focal seizure onset with localizing ictal and interictal EEG patterns. Subsequent focal resections resulted in improved seizure outcome.

Conclusions Corpus callosotomy can be used as both a therapeutic and diagnostic tool in the management of some refractory epilepsies.



## 132. PRIMARY PROGRESSIVE TONSILLAR HERNIATION IN CHIARI I MALFORMATION

*Timothy M. George, MD (Durham, NC)*

Introduction Progressive tonsillar herniation in Chiari I malformation has been described as principally a secondary phenomenon. Two cases are described in which progressive symptoms correlated to progressive tonsillar herniation without any other clear antecedent cause.

Methods A 2 yo male was followed for developmental delay and seizure disorder and was noted to develop worsening headaches, stridor and gait ataxia. A 16 yo female with renovascular hypertension was followed for progressive occipital headaches, left arm and hand weakness, with worsening headaches in spite of controlled hypertension. ICP monitoring demonstrated normal intracranial pressure. Ophthalmologic examination failed to demonstrate papilledema or visual field deficit in either patient. Neither patient underwent a lumbar puncture, lumbar CSF diversion, or had MRI evidence of intracranial hypotension.

Results Initial MRI in both cases demonstrated Chiari I malformation minimal tonsillar herniation of 2 mm and 5 mm respectively. Follow up imaging was obtained due to progressive symptoms that revealed progression of tonsillar descent of 10 mm and 21 mm without syringomyelia, ventriculomegaly, or other abnormality, respectively. Both patients underwent posterior fossa decompression with improvement of their symptoms. At follow-up, the patients remain clinically stable.

Conclusions Progressive tonsillar descent documented by MRI has been attributed as a phenomenon secondary to a progressive high-pressure intracranial process, low-pressure intraspinal process, or congenital spinal anomalies. Two cases are reported in which symptoms and tonsillar herniation were progressive as a primary process.

## 133. SLO: THE APPLICATION IN DETECTING INCREASED INTRACRANIAL PRESSURE

*Jeffrey E. Catrambone, Sr., MD; Charles J. Prestigiacomo, MD; Wenzhaun He (Newark, NJ)*

Introduction The diagnosis of papilledema is an important clinical entity especially in pediatric neurosurgery. An objective supplement to the clinical examination using modern technology is needed. This study evaluates the use of the Heidelberg scanning laser ophthalmoscope (SLO) to investigate papilledema.

Methods Patients with no underlying pathology were examined with the SLO for normative data. Digital retinal images centered on the optic nerve head were obtained and assessed for optic nerve height and presence/absence of edema. Potential differences in these parameters elicited by postural changes were assessed in six normal volunteers. In the second phase of the study, we compared normative data with patients suspected of having raised intracranial pressure.

Results The paired t-test was used to assess for possible postural changes in SLO measurements. Our results demonstrate no statistically significant differences between standing and supine positions. Thirteen patients with clinical evidence of increased intracranial pressure were examined, and the data set was compared with 30 normal volunteers. Data analysis reveals visually demonstratable differences in the optic nerve when compared to normal patients. However, current software does not demonstrate a statistically significant difference.

Conclusions Though currently used in the glaucoma patient population, SLO's 3-D ability to objectively evaluate the retina and the optic nerve head makes this technology a promising new tool in diagnosing papilledema.

## 134. MENINGIOMAS IN CHILDREN

*Stephanie Greene, MD; Chong C. Lee, MD, PhD; Jeffrey G. Ojemann, MD; Richard G. Ellenbogen, MD; Anthony M. Avellino, MD, (Seattle, WA)*

Introduction Pediatric meningiomas are a clinical rarity, representing 0.5-4.2% of all pediatric intracranial tumors. They are often seen in association with radiation therapy (RT) or neurofibromatosis type II (NF-II). These tumors are reported to be slightly more common in males, more often seen in an intraventricular location, and more likely to be multiple. We report one recent case of an intraventricular meningioma, and review the epidemiology, pathology, and natural history of eighteen additional cases of childhood meningioma from our institution.

Methods The Seattle Children's Hospital and Regional Medical Center brain tumor database was surveyed for patients presenting with meningioma between the years of 1940 and 2004. Eighteen additional patients were identified, and a retrospective chart review was performed.

Results Of the 19 patients, 10 (53%) were male. Ages ranged from 3 to 18, with a median of 12. Five (26%) patients had NF-II, and four (21%) had previously undergone RT. The tumor subtypes were five meningotheliomatous, four transitional, two malignant, two pasammomatous, one papillary, one clear cell, and four were not subclassified. Six (32%) patients had recurrent disease, including the two malignant meningiomas, one patient with NF-II, and one with a history of RT. Four (21%) patients died.

Conclusions A minimal male predominance was shown in our series. The intraventricular location was less common in our series than in others. These tumors demonstrated a more aggressive course than those in adults, with a much higher mortality rate. Pediatric meningioma is an important entity distinct from that seen in adults.

## 135. SUBAXIAL CERVICAL STENOSIS WITH MYELOPATHY IN CHILDREN WITH ACHONDROPLASIA: CASE REPORT

*John K. Houten, MD; David Gordon, MD; James T. Goodrich, MD, PhD (Bronx, NY)*

Introduction Spinal stenosis is common in achondroplasia due to congenital and acquired anatomic abnormalities including short, thickened pedicles and hyperplastic intervertebral discs. Children tend to become symptomatic from compression at the foramen magnum and upper cervical spine. Symptomatic stenosis in the subaxial cervical spine is rare and has not previously been reported in a child. We report the findings and management of a 7-year-old patient with quadraparesis from extensive subaxial cervical stenosis.

Methods A 7-year-old female with a history of two prior suboccipital decompressions for foramen magnum compression presented after six months of progressive quaraparesis. A MRI revealed stenosis from C2-T1 confluent spinal cord compression and extensive T2 signal abnormality at the C4 and C5 levels. A CT scan reformatted in the sagittal plane revealed kyphotic deformity of 31 degrees from C5-T1.

Results A C2-7 laminectomy was performed. Fusion with instrumentation was added from C2-T2 secondary to the presence of preoperative kyphotic deformity. Fixation consisted of C2 pars screws, C4-6 lateral mass screws, and T1-2 pedicle screws, with C3 and C7 screws omitted secondary to anatomic considerations. The patient recovered partial function with improved ability to walk, though quadraparesis persisted. There were no surgical complications.

Conclusions Subaxial cervical stenosis with spinal cord compression is a rare finding in children with achondroplasia that may cause symptoms of progressive myelopathy. This entity should be considered in achondroplastic children with symptoms of myelopathy, particularly if the more common finding of foramen magnum compression is not present or has previously been treated.

## 136. CYTOTOXICITY AND IN VIVO SAFETY OF CARBOPLATIN AND MINOCYCLINE FOR THE TREATMENT OF MALIGNANT GLIOMAS

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Introduction Efficacy of carboplatin (alkylating agent), used in combination with minocycline (anti-angiogenic), was studied in an experimental rat glioma model. In vivo cytotoxicity of the combined therapy, delivered intracranially via controlled-release polymers, was assessed and safety was established.

Methods Rat (9L gliosarcoma, F98 and C6 glioma), human (U251glioma) and metastatic breast carcinoma (EMT-6) cell lines were treated with carboplatin (20ug/ml), minocycline (25ug/ml), and a combination of both agents for 72 hours, with controls receiving no treatment. To establish safety of the combination treatment, 2% and 5% carboplatin, and 50% minocycline polymers were implanted into four groups of fisher-344 rats (3 animals/group). Groups one and two received carboplatin 2% and carboplatin 5% polymers alone respectively; groups three and four received carboplatin 2%/minocycline 50% and carboplatin 5%/minocycline 50% combination treatments respectively. The animals were evaluated and weighed on the day of surgery, and at various days thereafter.

Results Efficacy of combination treatment was assessed in vitro using 9L, F98, C6, and U251 cell lines. Combination treatment significantly decreased cell growth when compared to controls (P=0.001), and was more effective than carboplatin or minocycline alone. Drug-related toxicity in vivo was apparent in the carboplatin 5% and carboplatin 5%/minocycline 50% combination groups with 33.3% and 66.6% survival 20 days post-operatively respectively. Safety for carboplatin 2% alone and carboplatin 2%/minocycline 50% combination was established with 100% survival in both groups 20 days post-operatively.

Conclusions Based on these results, the effectiveness of combined therapy using these two agents is supported and further efficacy studies will be pursued using the carboplatin 2%/minocycline 50% combination therapy polymers.

## 137. POSTERIOR LUMBAR INTERBODY FUSION UTILIZING ALLOGRAFT IN CHILDREN -- A REPORT OF TWO CASES

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Introduction Congenital pars interarticularis defects in children are unusual, but they can lead to disabling lumbar pain, radiculopathy, sensory changes, and motor deficits. Many of these children present with radiologic signs of spinal instability. In the past, these were treated with bracing and, subsequently, with posterolateral fusion and fixation. We describe a new technique utilizing allograft interbody fusion.

Methods Two adolescents, one male and one female, presented with a combination of back pain, paresthesias, and radiculopathy. Workup consisted of plain radiographs, flexion/extension radiographs, and MRI. Both were treated conservatively, and both failed to respond. The two patients then underwent posterior laminectomy, discectomy, allograft interbody fusion, and pedicle screw fixation.

Results At six months follow-up, both children have demonstrated solid fusion with no graft complications. Both have returned to full and normal activity.

Conclusions Posterior lumbar interbody fusion utilizing allograft bone can be safely performed in children. This avoids second site graft complications, shortens postsurgical recovery, and is likely to have a high rate of fusion compared to standard posterolateral fusion techniques. Much more work remains to be done to assess new interbody fusion technologies in children.



## 138. IMPLANTATION OF AN ADDITIONAL GRAVITATIONAL UNIT IN SHUNTED PEDIATRIC HYDROCEPHALUS PATIENTS WITH OVERDRAINAGE SYNDROME

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Introduction Overdrainage syndrome in children features headache (irritability), vomiting, somnolence and sometimes vegetative signs with tachycardia and peripheral vasoconstriction. CCT or MRI reveal tight ventricles in many cases or at least a dysbalance between ventricular size (small) and cisterns (wide). If such a syndrome is frequent and no adjustable shunt system is already implanted surgical revision is recommended. In our institution the essential part of revision was the implatation of an additional gravitational unit (ShuntAssistent, Fa. Miethke, Germany).

Methods In order to evaluate the indication of this operation we retrospectively investigated the clinical course and brain images of 14 pediatric patients (0.1-15 years, mean 7,9 y). In 13/14 cases the ShuntAssistant was combined with a programmable valve. The follow up period ranged from 1 to 55 months (mean 21,8 mo).

Results In 10/14 children no further overdrainage episodes could be observed, 4/14 children developed only single and less severe episodes. Changing the valve's opening pressure alone did not influence the symptoms. No complications and no underdrainage occurred. The ventricular width did not change.

Conclusions Adding a gravitational unit to a preexisting or newly inserted shunt system is able to reduce the frequency and/or severity of an overdrainage syndrome in shunted hydrocephalic children.

## 139. TRANSIENT VENTRICULOPERITONEAL SHUNT DYSFUNCTION IN MYELODISPLASTIC CHILDREN WITH URINARY BLADDER INFECTION

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Introduction Shunt dysfunction for hydrocephalus can result from many mechanisms. To our knowledge, transient shunt malfunction in the presence of a significant urinary bladder infection that is reversed following only medical treatment of the bladder infection has not been reported.

Methods The clinical history of children with myelomeningocele and hydrocephalus who presented with signs and symptoms of shunt dysfunction and a significant urinary bladder infection were reviewed. We found a patient population that resolved the symptoms of their shunt dysfunction after appropriate treatment for their urinary bladder infection. None underwent surgical manipulation of their CSF shunt.

Conclusions Based on these patients, we believe that significant urinary bladder infection in the shunted myelodysplastic population may be enough to bring a subclinical shunt malfunction to clinical attention or may be enough to cause temporary distal peritoneal shunt malabsorption. The mechanism for the dysfunction is unclear. Treatment of the urinary bladder infection resolved the symptomatic shunt dysfunction without operative intervention in this group. However, we emphasize that careful observation of these patients should be made during hospitalization.

## 140. FAILURE PATTERNS AND LONG TERM OUTCOME IN PEDIATRIC PATIENTS TREATED FOR CRANIOPHARYNGIOMA

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Introduction The aim of our study was to assess the long-term results and failure patterns of pediatric patients treated with surgery and/or radiotherapy for craniopharyngioma.

Methods Records of 31 patients treated at our institution for craniopharyngioma were reviewed (1970-2002). Fourteen patients underwent gross total resection with observation, and six patients underwent limited resection with observation. Ten patients had a limited resection followed by external beam radiotherapy (EBRT) and one patient underwent cyst aspiration followed by P32 intracystic instillation. Mean dose of EBRT delivered was 4600 cGy(range 3932-5400 cGy).

Results OS and RFS at 8-years was 96% and 54%, respectively. One patient died of disease. Twelve patients had a subsequent recurrence. Of those patients, six had initial limited resection with observation and six had gross total resection (GTR) with observation. Mean time to recurrence was 18.5 months for patients that underwent limited resection, and 68.7 months for patients that underwent GTR. At the time of recurrence, 3/12 patients underwent limited resection and observation, 3/12 patients underwent limited resection and EBRT, 6/12 patients underwent EBRT without resection. The three patients who had surgery followed by observation had a second recurrence. 8 yr RFS for the 11 patients that received initial RT was 100%. 8 yr RFS for the 20 patients that did not receive initial RT was 28%.

Conclusions Overall survival for pediatric patients with craniopharyngioma is excellent. Radiotherapy continues to play a key role in the management of craniopharyngioma both following subtotal resection and at the time of recurrence.

141. SIX YEARS EXPERIENCE WITH THE FIRST GRAVITATIONAL SHUNT FOR CHILDREN: THE PAEDI-GAV

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Introduction The typical symptoms of overdrainage accrue with the beginning of independent sitting and walking. An increasing siphoning with ongoing growth aggravates the consequences of overdrainage and fixes them irreversible. The PAEDI-GAV is the first paediatric shunt with a gravitational unit for children.

Methods Within the last six years, 70 children with hydrocephalus of various ethiologies received a PAEDI-GAV. In 15 children we inserted the valve to compensate for sequels of overdrainage induced by conventional differential valve without compensation of siphoning. In 55 children the PAEDI-GAV was the first treatment of the hydrocephalic condition, mostly during the first three months of life.

Results In all children who received the PAEDI-GAV to compensate for overdrainage this objective could be reached. Those children who received the PAEDI-GAV as initial treatment presented no signs of overdrainage (including a normal development of the head circumference) during the first three years of life. However 30% of the children dropped gradually from the 50th percentile to the 10th and below when their height increased thereafter.

Conclusions The PAEDI-GAV prevents overdrainage in children in the first two to three years of life. Thereafter, the hydrostatic pressure, which has to be compensated, increases with growth necessitating a higher opening pressure of the gravitational unit. An adjustable gravitational unit would be valuable to overcome the necessity of an operation to adjust the adequate hydrostatic compensation.

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