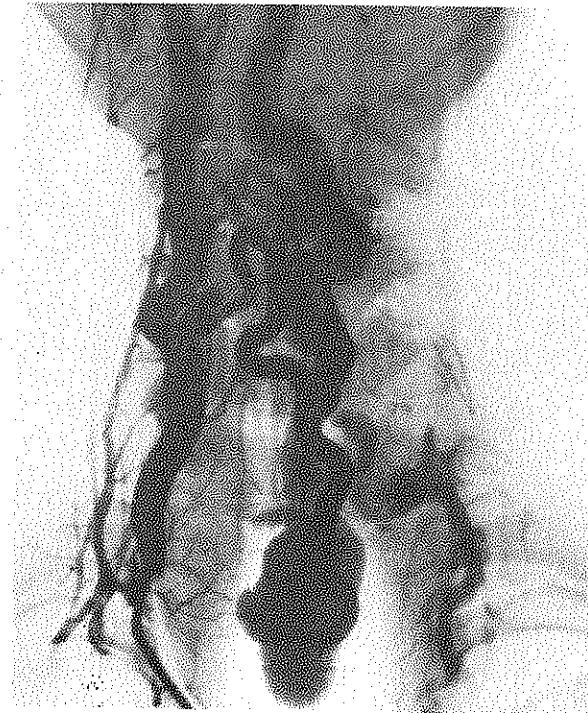


Flannery

**Section of Pediatric Neurological Surgeons
of the
American Association of Neurological Surgeons**

14th ANNUAL MEETING



**Westin Oaks Hotel
Houston, Texas
December 4-6, 1985**

PROGRAM SUMMARY

Paolo Raimondi Lecturers

Pediatric Section Chairmen

Pediatric Annual Meeting Sites

Exhibitors

14th Annual Meeting Scientific Program

14th Annual Meeting Scientific Abstracts

Pediatric Section Member Listing

**This program has been approved by the
Joint Committee on Education of the
American Association of Neurological
Surgeons and Congress of Neurological
Surgeons for a maximum of 13 hours of
Category I credit toward the Continuing
Education Award in Neurosurgery.**

PAOLO RAIMONDI LECTURERS

E. Bruce Hendrick	1978
Paul C. Bucy	1979
Floyd Gilles	1980
(Panel Discussion)	1981
(Panel Discussion)	1982
Derek Harwood-Nash	1983
Anthony E. Gallo, Jr.	1984

PEDIATRIC SECTION CHAIRMEN

Robert L. McLaurin	1972-73
M. Peter Sayers	1973-74
Frank Anderson	1974-75
Kenneth Shulman	1975-76
E. Bruce Hendrick	1976-77
Frank Nulsen	1977-78
Luis Schut	1978-79
Fred Epstein	1979-81
Joan L. Venes	1981-83
Harold J. Hoffman	1983-85
William R. Cheek	1985-

PEDIATRIC ANNUAL MEETING SITES

Cincinnati	1972
Columbus	1973
Los Angeles	1974
Philadelphia	1975
Toronto	1976
Cleveland	1977
Philadelphia	1978
New York	1979
New York	1980
Dallas	1981
San Francisco	1982
Toronto	1983
Salt Lake City	1984
Houston	1985

The Pediatric Section of Neurological Surgery of the American Association of Neurological Surgeons gratefully recognizes the support of the following exhibitors for the 1985 Pediatric Annual Meeting:

American V. Mueller - Chicago, Illinois
Camino Laboratories, Inc. - San Diego, California
Codman & Shurtleff, Inc. - Randolph, Massachusetts
Cordis Corporation - Miami, Florida
Denver Biomaterials, Inc. - Evergreen, Colorado
Holter-Hausner International - Bridgeport, Pennsylvania
Malliner Laboratories - Edmonton, Alberta, Canada
Pudenz-Schulte Medical - Santa Barbara, California
U.S. Army Medical Department - Washington, D.C.

All registrants are encouraged to visit the exhibit area frequently during the meeting.

PROGRAM
PEDIATRIC SECTION
AMERICAN ASSOCIATION OF NEUROLOGICAL SURGEONS

Westin Oaks Hotel
Houston, Texas

December 4-6, 1985

TUESDAY, DECEMBER 3, 1985

6:00 - 8:00 p.m. Registration-Grand Foyer

7:00 - 9:00 p.m. Reception - The Roof (21st Floor)

WEDNESDAY, DECEMBER 4, 1985

7:00 a.m. Registration - Grand Foyer

8:00 a.m. Meeting-Consort I, Grand Ballroom

Opening Remarks

William R. Cheek

Welcoming Remarks

Robert Grossman

8:15 a.m. Annual Paolo Raimondi Lecture
"Lifetime Management of Hydrocephalus"
Frank E. Nulsen

TUMORS - Moderators: Arthur Marlin, Gordon McComb

9:00 a.m. 1. "Brain Tumors in Neonates, Infants and Toddlers"
A. Leland Albright
Pittsburgh, Pennsylvania

9:10 a.m. *2. "Brain Tumors in the First Two Years of Life"
Corey Raffel, Michael Edwards
San Francisco, California

9:20 a.m. Discussion for Papers 1-2

9:30 a.m. 3. "Hypothalamic Glioma in Childhood"
M. Kathryn Hammock
Washington, D.C.

9:40 a.m. 4. "Thalamic Gliomas in Children"
Kenneth Shapiro
Bronx, New York

9:50 a.m. Discussion for Papers 3-4

10:00 a.m. **COFFEE BREAK - Grand Foyer**
View Exhibits - Grand Foyer

TUMORS - Moderators: David McCullough, John Shillito

10:30 a.m. 5. "Benign Astrocytomas - Clinical and Pathologic Features
of Twenty Cases"
Thomas S. Berger, Boleslaw Liwnicz,
John M. Tew, Mark Greenberg
Cincinnati, Ohio

10:40 a.m. 6. "Subtypes of Cerebral Astrocytoma in Children"
Robert A. Sanford, Tony DiSclafani,
Larry E. Kun, Edward H. Kovnar
Memphis, Tennessee

10:50 a.m. Discussion for Papers 5-6

11:00 a.m. 7. "Biology of Midline Tumors in Children"
A.J. Raimondi, Katsushi Taomoto,
Jan Leestma, Tadanori Tomita
Chicago, Illinois

11:10 a.m. Discussion for Paper 7

11:15 a.m. 8. "Intramedullary Astrocytomas of Childhood, Results
of Operative Management in 63 Children"
Jeffrey H. Wisoff, Fred Epstein
New York, New York

11:25 a.m. Discussion for Paper 8

11:30 a.m. 9. "Sellar Lesions in Children and Report of an ACTH
Producing Adenoma with Ultrastructural Features
of Steroid Producing Cells"
Steven Kanter, J. Parker Mickle, Steve Hunter
Gainesville, Florida

11:40 a.m. Discussion for Paper 9

11:45 a.m. 10. "CT, MR, Light and Electron Microscopic Findings
in Three Cases of Pineocytomas in Children"
Patrick T. Tracy, Uma P. Kalyan-Raman,
William C. Hanigan
Peoria, Illinois

11:55 a.m. Discussion for Paper 10

12:00 noon **LUNCH - Consort II, Grand Ballroom**

TUMORS - Moderators: Fred Epstein, W. Jerry Oakes

1:00 p.m. 11. "Long Post-Operative Survival with Primary
Intracranial Sarcoma"
Philip H. Cogen, Mark C. Belza,
Stephen Smith
Palo Alto, California

1:10 p.m. Discussion for Paper 11

1:15 p.m. *12. "Medulloblastoma: A Review of the Factors Influencing
Prognosis. The Importance of Cellular Differentiation"
Anthony J. Caputy, David C. McCullough, Herbert J. Manz,
Kathleen Patterson, M. Kathryn Hammock
Washington, D.C.

1:25 p.m. 13. "Preliminary Results of Decreased Whole Brain and Spinal
Cord Irradiation in Children with Medulloblastoma"
Michael Edwards, Victor A. Levin, William M. Wara
San Francisco, California

1:35 p.m. Discussion for Papers 12-13

- 1:45 p.m. *14. "CT Myelographic Evaluation of Spinal Metastasis in PNET of the Cerebellum"
Richard George, John P. Laurent,
Charles McCluggage, William R. Cheek
Houston, Texas
- 1:55 p.m. Discussion for Paper 14
- 2:00 p.m. 15. "The Value of Early Re-operation in Pediatric Brain Tumor Surgery"
Harold L. ReKate, Andrew G. Shetter,
Volker K. Sonntag
Phoenix, Arizona
- 2:10 p.m. Discussion for Paper 15
- 2:15 p.m. 16. "8 in 1 Chemotherapy for Malignant Brain Tumors in Children"
Edward J. Kosnik, Arlynn Mulne, Frederick Ruymann
Columbus, Ohio
- 2:25 p.m. Discussion for Paper 16
- 2:30 p.m. **COFFEE BREAK - Grand Foyer**
View Exhibits - Grand Foyer
- TUMORS - Moderators: Paul Chapman, Eldon Foltz**
- 3:00 p.m. 17. "Methotrexate Leukoencephalopathy Mimicking Cerebral Abscess on CT Brain Scan: A Case Report"
Paul Steinbok, Olof Flodmark
Vancouver, British Columbia, Canada
- 3:10 p.m. 18. "Malignant Gliomas in Children Previously Treated for Acute Lymphocytic Leukemia"
D. Luke Knox, Arnold H. Menezes,
Robert L. Schelper, Renee Ellerbroek
Iowa City, Iowa
- 3:20 p.m. Discussion for Papers 17-18
- 3:30 p.m. 19. "Open Implantation of I-125 Seeds for Recurrent Malignant Brain Tumors"
Walker L. Robinson, Pradip P. Amin,
Louis W. Solomon, Wilfred Sewchand
Baltimore, Maryland
- 3:40 p.m. Discussion for Paper 19
- 3:45 p.m. 20. "Treatment of Cystic Craniopharyngioma with Stereotactic Instillation of ³²Phosphorous"
Stephen M. Papadopoulos, William H. Bierwalters,
James A. Taren
Ann Arbor, Michigan
- 3:55 p.m. Discussion for Paper 20
- ARNOLD CHIARI MALFORMATION -**
- 4:00 p.m. 21. "The Symptomatic Arnold-Chiari Malformation: Review of Experience and Speculation"
William O. Bell, Edward B. Charney, Derek A. Bruce,
Leslie N. Sutton, Luis Schut
Philadelphia, Pennsylvania

- 4:10 p.m. 22. "Evaluation and Surgical Management of the Arnold-Chiari II Malformation: Use of Magnetic Resonance and Intraoperative Ultrasound"
Keith L. Black, Joan L. Venes
Ann Arbor, Michigan
- 4:20 p.m. *23. "Central Sleep Apnea in Arnold-Chiari Type I Deformity"
Anthony Jabre, Thomas S. Berger
Cincinnati, Ohio
- 4:30 p.m. Discussion for Papers 21-23
- 5:00 p.m. Annual Business Meeting - Members Only
- THURSDAY, DECEMBER 5, 1985**
- 7:00 a.m. Registration - Grand Foyer
- TRAUMA - Moderators: Robert McLaurin, Marion Walker**
- 8:00 a.m. 24. "Aggressive Physiological Monitoring of the Pediatric Patient with Elevated Intracranial Pressure"
Samuel S. Kasoff, Donovan Holder, Jack Stern,
Nanakram Agarwald, Anthony San Filippo, Thomas A. Lansen
Valhalla, New York
- 8:10 a.m. 25. "Prevention of Intracranial Hypertension in Severe Pediatric Head Injuries by Improving Neural Axis Compliance"
Arno Fried, Kenneth Shapiro
Bronx, New York
- 8:20 a.m. Discussion for Papers 24-25
- 8:30 a.m. 26. "The Clinical Measurement of Brain Tissue Pressures - A New Device Advantageous for Measuring Intracranial Pressures in the Pediatric Age Group"
Richard C. Ostrup, Michael M. Todd, Mark H. Zornow,
Lawrence F. Marshall, Thomas G. Luerssen
San Diego, California
- 8:40 a.m. Discussion for Paper 26
- 8:45 a.m. 27. "Measuring Regional Cerebral Blood Flow and Intracranial Pressure in Pediatric Submersion Accidents with Cardiopulmonary Arrest"
David H. Beyda
Phoenix, Arizona
- 8:55 p.m. 28. "Neuropsychological Outcome After Severe Pediatric Near-Drowning"
Terece Stovall Bell, Leah Ellenberg, J. Gordon McComb
Los Angeles, California
- 9:05 a.m. Discussion for Papers 27-28
- 9:15 a.m. *29. "Severe Head Injury Outcome in Pediatric Versus Adult Patients"
Anthony M. Alberico, John D. Ward, Sung C. Choi
Richmond, Virginia

- 9:25 a.m. 30. "Prognostic Implication of Glasgow Coma Scale in Severely Head Injured Children: The Pilot Traumatic Coma Data Bank"
T.S. Park, Wayne Alves, John A. Jane, Jan Hinkle
Charlottesville, Virginia
- 9:35 a.m. Discussion for Papers 29-30
- 9:45 a.m. *31. "The Shaken Baby Syndrome"
Ann-Christine Duhaime, Thomas A. Gennarelli,
Lawrence E. Thibault, Derek A. Bruce
Philadelphia, Pennsylvania
- 9:55 a.m. Discussion for Paper 31
- 10:00 a.m. **COFFEE BREAK - Grand Foyer**
View Exhibits - Grand Foyer
- TRAUMA - Moderators: Robert Sanford, Joan Venes**
- 10:30 a.m. 32. "The Rare Association of a Leptomeningeal and Arachnoid Cysts"
David Knierim, Maged Abu-Assal
Loma Linda, California
- 10:40 a.m. Discussion for Paper 32
- 10:45 a.m. *33. "Pharmacokinetics of Intraventricular Vancomycin in Hydrocephalic Rats"
Matthew Howard, M. Sean Grady, T.S. Park, Michael Scheld
Charlottesville, Virginia
- 10:55 a.m. 34. "Vancomycin Prophylaxis for CSF Shunt Procedures"
Johanna Goldfarb, Samuel Kasoff, Joseph Sciarrino
New York, New York
- 11:05 a.m. 35. "Reduced Bacterial Adherence to Neurosurgical Prostheses"
David J. Gower, Verlia C. Gower,
Stephen H. Richardson, David L. Kelly
Winston-Salem, North Carolina
- 11:15 a.m. Discussion for Papers 33-35
- 7:00 p.m. Reception - The Roof (21st Floor)
- 8:00 p.m. Annual Banquet - The Roof (21st Floor)

FRIDAY, DECEMBER 6, 1985

7:00 a.m. Registration - Grand Foyer

SPINAL DISORDERS - Moderators: R. Michael Scott, David Klein

- 8:00 a.m. 36. "Rotary Atlantoaxial Luxations in Adolescents"
Arnold H. Menezes
Iowa City, Iowa
- 8:10 a.m. Discussion for Paper 36
- 8:15 a.m. 37. "Pediatric Spinal Cord and Vertebral Column Injuries"
Joseph M. Zabramski, Mark N. Hadley, Carol Browner,
Harold Rekate, Volker K.H. Sonntag
Phoenix, Arizona
- 8:25 a.m. Discussion for Paper 37

- 8:30 a.m. 38. "The Challenge of the Upper Thoracic Spine"
Stephen R. Marano, Stephen Bloomfield, Harold L. Rekate
Phoenix, Arizona
- 8:40 a.m. Discussion for Paper 38
- 8:45 a.m. 39. "Juvenile Discs"
A. Loren Amacher, Lloyd Zucker
Hartford, Connecticut
- 8:55 a.m. Discussion for Paper 39
- 9:00 a.m. 40. "Laser Resection of 50 Spinal Lipomas"
David G. McLone, Thomas P. Naidich
Chicago, Illinois
- 9:10 a.m. 41. "Lipomyelomeningocele in Infants and Children"
Rebecca Brightman, Edward J. Kosnik, Martin P. Sayers
Columbus, Ohio
- 9:20 a.m. 42. "Lumbosacral Intradural Intramedullary Myolipoma; Unusual Features of a Rare Tumor"
David S. Knierim, Margaret Wacker, Abu-Assal Maged
Loma Linda, California
- 9:30 a.m. Discussion for Papers 40-42
- 9:45 a.m. **COFFEE BREAK - Grand Foyer**
View Exhibits - Grand Foyer
- Moderators: Charles Duncan, Anthony Gallo
- 10:15 a.m. 43. "Associated Spinal Anomalies of Cervical Meningocele and Their Radiographic Evaluation"
J.B. Delashaw, T.S. Park, Wayne Cail,
Dennis G. Vollmer
Charlottesville, Virginia
- 10:25 a.m. 44. "NMR of the Tethered Cord"
Nazih Mourfarrij, Joseph F. Hahn
Cleveland, Ohio
- 10:35 a.m. Discussion for Papers 43-44
- 10:45 a.m. 45. "Tethered Spinal Cord - Extensibility of Lumbar and Sacral Cord"
Satoshi Tani, Shokei Yamada
Loma Linda, California
- 10:55 a.m. *46. "Metabolic and Histologic Studies in a Chronic Tethered Cord Model"
Thomas Purtzer, Shokei Yamada, Satoshi Tani
Loma Linda, California
- 11:05 a.m. Discussion for Papers 45-46
- 11:15 a.m. *47. "Hypophosphatemia and Craniosynostosis"
Hatem Megahed, John P. Laurent, William R. Cheek
Houston, Texas
- 11:25 a.m. Discussion for Paper 47

- 11:30 a.m. 48. "Pediatric Neurosurgical Implications of the Amniotic Band Disruption Complex"
Roger J. Hudgins, Michael Edwards,
Douglas K. Ousterhout, Mahin Golabi
San Francisco, California
- 11:40 a.m. Discussion for Paper 48
- 11:45 a.m. 49. "Auditory and Somatosensory Evoked Potentials in the Localization of Brainstem Gliomas"
John W. Walsh, Robin Gilmore, Augusto C. Lastimosa,
Robert J. Baumann, Norman H. Bass
Lexington, Kentucky/Arlington, Texas/Augusta, Georgia
- 11:55 a.m. Discussion for Paper 49
- 12:00 noon 50. "Pathological Factors Which Effect the Evoked Response"
Derek A. Bruce, Luis Schut, Leslie N. Sutton,
Byung-kyu Cho
Philadelphia, Pennsylvania
- 12:10 p.m. Discussion for Paper 50
- 12:15 p.m. LUNCH - The Roof (21st Floor)
- Moderators: Howard Eisenberg, Edward Kosnik
- 1:15 p.m. 51. "Outpatient Metrizamide Studies in Children"
Alexa I. Canady
Detroit, Michigan
- 1:25 p.m. Discussion for Paper 51
- 1:30 p.m. 52. "The Anterior Commissure as a Major Landmark in MRI"
Thomas P. Naidich
Chicago, Illinois
- 1:40 p.m. Discussion fo Paper 52
- 1:45 p.m. 53. "Benign Extra-axial Collections of Infancy"
Patrick L. Carolan, Robert L. McLaurin, Jeffrey Towbin,
John Egelhoff, Richard Towbin
Cincinnati, Ohio
- 1:55 p.m. Discussion for Paper 53
- 2:00 p.m. 54. "Rate of Decrease in Ventricular Size After Ventriculo-peritoneal Shunt Placement"
Arden Reynolds, Janice R.L. Smith, Kai Haber,
Covina, California/Tucson, Arizona
- 2:10 p.m. Discussion for Paper 54
- 2:15 p.m. 55. "Computerized Single Probe System: Assessment of CSF Flow Rates Through the Shunting Devices"
Osamu Sato, Mitsunori Matsumae, Morikazu Ueda,
Yutaka Suzuki
Kanagawa, Japan
- 2:25 p.m. Discussion for Paper 55
- 2:30 p.m. COFFEE BREAK - Grand Foyer
View Exhibits - Grand Foyer

Moderators: Derek Bruce, Shokei Yamada

- 3:00 p.m. 56. "CSF Drainage in the Dead Rabbit"
J. Gordon McComb, Shigeyo Hyman, Martin H. Weiss
Los Angeles, California
- 3:10 p.m. Discussion for Paper 56
- 3:15 p.m. 57. "Third Ventricle BB and Hydrocephalus: Operative Cure"
Eldon L. Foltz
Orange, California
- 3:25 p.m. Discussion for Paper 57
- 3:30 p.m. 58. "Randomized Indomethacin Trial for the Prevention of Intraventricular Hemorrhage in Very Low Birth Weight Neonates"
Charles C. Duncan, Laura R. Ment, Richard A. Ehrenkranz,
William B. Stewart
New Haven, Connecticut
- 3:40 p.m. Discussion for Paper 58
- 3:45 p.m. 59. "Intracranial Hemorrhage in the Post-Term Infant"
Michael D. Heafner
San Antonio, Texas
- 3:55 p.m. Discussion for Paper 59
- 4:00 p.m. 60. "Diagnosis and Management of Intracranial Aneurysms and Pseudoaneurysms Presenting During Infancy and Childhood"
Francisco Gutierrez, Herbert Engelhard
Chicago, Illinois
- 4:10 p.m. Discussion for Paper 60
- 4:15 p.m. 61. "Experience with a Modified Jane Procedure for Scaphocephaly"
W. Jerry Oakes, Joseph Piatt
Durham, North Carolina
- 4:25 p.m. Discussion for Paper 61
- 4:30 p.m. 62. "Neurosurgery in a Neonatal Intensive Care Unit"
Thomas S. Berger
Cincinnati, Ohio
- 4:40 p.m. Discussion for Paper 62

* denotes Resident Paper

SCIENTIFIC ABSTRACTS

1. BRAIN TUMORS IN NEONATES, INFANTS, AND TODDLERS

A. Leland Albright, M.D. (Pittsburgh PA)

In order to compare the brain tumors of neonates (0-2 months), infants (3-12 months), and toddlers (13-24 months), I reviewed the medical records of 111 such children treated at the Children's Hospital of Pittsburgh during the past 25 years. Brain tumors occurred as frequently in children less than 2 years old as in older children; 16.2% of 685 tumors occurred in children less than 2. Tumors occurred sporadically throughout those 2 years; they were as common in neonates as in any other 2 month interval during the 2 years. The ratio of supratentorial to infratentorial tumors shifted from a strong supratentorial predominance in neonates to an equal ratio in infants to an infratentorial predominance in toddlers. Three symptoms occurred frequently in all three groups; irritability, lethargy, and vomiting, and the children were often misdiagnosed as having pyloric stenosis, gastroenteritis, or meningitis. The major signs in neonates were macrocephaly and hydrocephalus; lateralizing findings were infrequent in all three groups. The CT scan appearance of the tumors were similar to the appearance in older children. Neurosurgeons often misinterpreted CT scans as showing rare tumors, rather than the tumors these children commonly develop. The most common supratentorial tumors were medulloblastomas, ependymomas, and astrocytomas. Rare tumors comprised only 15-20% of the tumors in the three age groups. The operative mortality during the entire period was 20%, but only 4% in the past 25 patients. Operative techniques differed substantially, especially in prevention of cortical collapse. Operations are probably not indicated for teratomas, which can be diagnosed by the presence of squames in the CSF. There is no data correlating extent of resection with outcome in these children. Survival is best for choroid plexus papillomas, intermediate for diencephalic and hemispheric tumors, and worst for posterior fossa tumors and teratomas. The morbidity of whole brain radiotherapy is unacceptably high, and adjunctive therapy should probably consist of focal radiation and chemotherapy.

*2. BRAIN TUMORS IN THE FIRST TWO YEARS OF LIFE

Corey Raffel, M.D., Ph.D., Michael S.B. Edwards, M.D.
(San Francisco CA)

Thirty-one patients with symptoms beginning before their second birthday have been treated for intracranial tumors at UCSF from 1972 through 1984. Of these patients, twenty were boys. The most common presenting symptoms were those of increased intracranial pressure (twenty patients); five patients presented with symptoms of motor dysfunction, four with seizures, three with failure to thrive, and two with loss of developmental milestones. The most common presenting signs were ataxia and/or cranial nerve palsy (fourteen), followed by signs of intracranial pressure (nine), and focal cerebral deficit (eight). All patients but one had an operation directed at their tumor. Eighteen patients had posterior fossa tumors, of which ten were medulloblastomas. The remaining eight tumors included five moderately anaplastic astrocytomas (two cerebellar and three brainstem), two malignant ependymomas, and one malignant pineal germ cell neoplasm. Of the thirteen supratentorial lesions, five were malignant astrocytomas, three were optic nerve gliomas, and one each were malignant ependymoma, ependymoma, juvenile pilocytic astrocytoma, and cerebral neuroblastoma. All patients but one received post-operative therapy, either radiation (eleven), chemotherapy (four), or a combination of the two (sixteen). Two patients are lost to followup. Eleven patients have died with a mean survival of nineteen months. The eighteen surviving patients include six of ten medulloblastomas. The mean survival of the eighteen is five years. Of the surviving patients, six are currently being treated for tumor recurrence. Five patients are significantly disabled by blindness and/or low intelligence. Other long term problems include scoliosis after spinal irradiation and pituitary dysfunction. Thus, of the thirty-one patients, seven (22.6%) have the potential for high quality, long term survival.

3. HYPOTHALAMIC GLIOMA IN CHILDHOOD

M. Kathryn Hammock, M.D. (Washington D.C.)

Tumors of the hypothalamus are relatively uncommon in children and, perhaps related to the necessarily limited experience with these lesions in any single center, considerable controversy surrounds their classification and the consequences of treatment. This report reviews the long-term followup of five surgically confirmed hypothalamic gliomas in patients varying in age from 10 months to 13 years. Three patients presented with a diencephalic syndrome, one with unilateral decreased visual activity, and one with signs and symptoms of elevated intracranial pressure. Tumor was demonstrated by cranial computed tomography (CCT) in each case. Surgical exploration with subtotal tumor resection was carried out in all patients with no intraoperative complications or post operative morbidity. A subsequent ventricular shunting procedure was required in four patients because of persistent ventriculomegaly. Each child received radiotherapy to the tumor site postoperatively. Serial CCT scans following treatment have shown a progressive decrease in residual tumor mass in four children. One child, who had evidenced early tumor regression, had tumor progression 2.11 years after surgery. A second craniotomy with tumor resection was performed on this patient and a second course of radiotherapy was given. A CCT scan six months after this second course of treatment again has indicated tumor regression. Preoperative endocrinological evaluation demonstrated an elevated ACTH level in one child but was normal in the remaining four. Postoperatively two patients have been shown to have decreased growth hormone and two to have depressed thyroid function; two females have had early breast development. At this time all patients are involved in activities normal for their ages and functioning well, 7.9, 7.7, 6.7, 5.4, and 3.8 years after initial diagnosis.

4. THALAMIC GLIOMAS IN CHILDREN

Kenneth Shapiro, M.D. (Bronx NY)

Thalamic gliomas are usually considered inoperable tumors with a variable outcome reported in children. In the past treatment at this institution has followed traditional guidelines and consisted of neuroradiologic diagnosis, shunting, if needed, and radiation therapy. The long term results have been variable with some children enjoying long term survival and others dying from the delayed effects of radiation therapy.

With more precise radiologic evaluation our approach to treatment has changed: some children are followed with serial imaging without treatment; others undergo biopsy and combined therapy, while others have undergone excision of the tumor. The rationale for this strategy as well as results will be presented.

5. BENIGN ASTROCYTOMAS--CLINICAL AND PATHOLOGIC FEATURES OF TWENTY CASES

Thomas S. Berger, M.D., Boleslaw Liwnicz, M.D., Ph.D.,
John M. Tew, Jr., M.D., Mark Greenberg, M.D.
(Cincinnati OH)

Twenty benign astrocytomas were treated surgically by two of the authors (TSB, JMT). These patients were followed from two to twenty-eight years. There were eleven infratentorial and nine supratentorial cases. There were four recurrences but two have no evidence of tumor by computed tomography four to seven years after the second operation. One patient with a cystic cerebellar astrocytoma had a recurrence of the same type of tumor in the same location twenty-eight years after the initial operation but is less than one year since the second procedure.

We will discuss the clinical, radiographic and pathologic features of astrocytic tumors that are associated with long-term survival when treated by surgery alone.

6. SUBTYPES OF CEREBRAL ASTROCYTOMA IN CHILDREN

Robert A. Sanford, M.D., Tony DiSclafani, M.D.,
Larry E. Kun, M.D., Edward H. Kovnar, M.D. (Memphis TN)

Low grade astrocytomas of the cerebral hemisphere are categorized histologically. Anatomical location, age of the patient, and the histological subtype allow prediction of biologic behavior. The authors describe two subgroups of low grade astrocytomas in children whose biologic behavior are extremely similar within their respective group. Their histologic characteristics are unremarkable. These uncommon subgroups of low grade astrocytoma need to be recognized because the recommended treatment and prognosis are different.

TYPE A- These eleven children had a remarkable similar presentation. Each had a clinical history of many years of poorly controlled, complex seizures. Each demonstrated a small low density lesion of the cerebral white matter on CAT scan which failed to enhance with intravenous contrast. Each of the patient's previously uncontrollable seizures were brought under control with surgical resection or biopsy plus irradiation. Many of the children had delayed intellectual and psychomotor development.

TYPE B- The patients present with seizure disorders and neurologic signs of diffuse cerebral involvement. CT scan is only subtly abnormal, with generalized mass effect, unimpressive areas of low density, and lack of focal enhancement. NMR scan demonstrates a diffusely infiltrating process involving multiple lobes of the brain, the thalamus, and mesencephalon. Biopsy reveals a low grade astrocytoma. Response to irradiation has been dramatic but transitory.

7. BIOLOGY OF MIDLINE TUMORS IN CHILDREN

Anthony J. Raimondi, M.D., Katsushi Taomoto, M.D.,
Jan Leestma, M.D., Tadanori Tomita, M.D. (Chicago IL)

We have studied 254 children with midline tumors, clinically and histopathologically. Supratentorial and infratentorial tumors accounted for 48% and 52%, respectively, divided into 10 groups by their anatomical location and/or histological characteristics: medulloblastoma (vermis tumor) 27.2%, brain stem glioma (16.5%), craniopharyngioma (11%), thalamic tumor (10.6%), optic glioma (9%), pineal tumor (8.3%), IVth ventricle tumor (7.9%), hypothalamic (6.3%), IIIrd ventricle tumor (2%), and clivus tumor (0.2%). There was a preponderance of males for III ventricle, perineal, and infratentorial tumors while the preponderance was of females in optic glioma and hypothalamic tumors. Ventricular tumors and optic tract glioma were more common in the younger ages, while craniopharyngioma and pineal tumors affected more commonly the older ages. Other tumors were in between. Surgery was performed for craniopharyngioma, ventricular tumors and medulloblastoma, while optic tract and hypothalamic tumors were only biopsied or partially resected. We presently proceed directly to radiation therapy for optic pathway and hypothalamic tumors, since biopsy has nothing to offer concerning treatment. The outcome of the children was most closely correlated with age and anatomical tumor location, not histological malignancy.

8. INTRAMEDULLARY ASTROCYTOMAS OF CHILDHOOD, RESULTS OF OPERATIVE MANAGEMENT IN 63 CHILDREN

Jeffrey Wiscoff, M.D., Fred Epstein, M.D. (New York NY)

Between December 1979 and January 1984, 80 children underwent radical resection ("gross total removal") of extensive intramedullary astrocytomas of the spinal cord. Sixty-two children were available for evaluation of functional outcome in July 1985. The patients were followed for an average of 32 months (range 12-68 months) after surgery.

The outcome following radical resection of these tumors was directly related to the preoperative neurological status and pathological grade of the tumor. Although a transient increase in weakness or sensory loss was not unusual in the immediate post-operative period, only three patients suffered a permanent increase in neurological deficit following surgery. Patients with paraparesis or quadriparesis who were ambulating before surgery had stabilization of their deterioration and usually had neurological and functional improvement over several weeks. Among the patients with severe deficit preoperatively, only three made a significant improvement although the downhill course abated in the remainder.

The operative mortality was 0%. The long term case mortality was 10% for Grade I & II astrocytomas and 75% for the malignant astrocytomas. These intermediate term results suggest that aggressive surgical management offers potential for neurological recovery and perhaps cure. Observations on the natural history of these tumors and the role of adjunct radiation and chemotherapy will be discussed.

9. SELLAR LESIONS IN CHILDREN AND REPORT OF AN ACTH PRODUCING ADENOMA WITH ULTRASTRUCTURAL FEATURES OF STEROID PRODUCING CELLS

Steven Kanter, M.D., J. Parker Mickle, M.D.,
Steve Hunter, M.D. (Gainesville FL)

A review of brain tumors in children at the University of Florida Medical Center over the past five years disclosed fifteen lesions confined primarily to the sellar region. There were ten adenomas, two craniopharyngiomas, one eosinophilic granuloma, one Rathke's cleft cyst, and one ACTH producing adenoma with ultrastructural features suggestive of steroid production. All of these tumors were removed transsphenoidally. The fourteen year old male harboring the last tumor presented with growth failure, headaches, and mild hypercortisolism. This tumor showed aggressive behavior in that it invaded dura, and extended into the pituitary infundibular stalk. The tumor, studied by light microscopy, electron microscopy, and immunocytochemistry disclosed two cell types- a population of small cells associated with ACTH producing adenomas and a second group of larger cells strikingly similar to the steroid producing cells of the adrenal cortex. This unique tumor should be differentiated from the oncocytomas and granular cell tumors of the pituitary.

10. CT, MR, LIGHT AND ELECTRON MICROSCOPIC FINDINGS IN THREE CASES OF PINEOCYTOMAS IN CHILDREN

Patrick T. Tracy, M.D., Uma P. Kalyan-Raman, M.D.,
William C. Hanigan, M.D., Ph.D. (Peoria IL)

Detailed clinical and pathological descriptions of primary tumors of the pineal parenchyma are infrequent. This report will summarize these findings in three children with pineocytomas.

The ages of the patients ranged from five to twelve years. Two children presented with complaints of headaches for two weeks. The third patient had complained of headaches two years previously and undergone a ventriculoperitoneal shunt for a presumptive diagnosis of aqueductal stenosis. Neurological examinations showed ataxia and papilledema in two patients; abnormalities of eye movements were not demonstrated.

CT scans showed dilatation of the third and lateral ventricles but failed to visualize any mass lesions. The MR scans demonstrated the pineal tumors in all patients. Surgical explorations via the supracerebellar approach resulted in complete tumor removal in one patient without operative morbidity.

Light microscopy demonstrated sheets of uniform appearing cells resembling pinealocytes with dense chromatin and a faint eccentrically located eosinophilic cytoplasm. Calcification and pineocytomatous rosettes were seen in all three specimens with little evidence of atypical mitosis or necrosis. Rosenthal fibers along with a delicate extracellular GFAP staining were visualized in one specimen. Ganglionic differentiation was not present in any of these cases.

Ultrastructurally, the predominant feature was the presence of cells with uniform nuclei, scant cytoplasm, numerous cell processes with microtubules, occasional dense core vesicles, and smooth and rough endoplasmic reticulum. Intracytoplasmic filaments were conspicuously absent.

In summary, these cases demonstrate that the MR scan may be more sensitive than both the clinical exam and CT scan in the diagnosis of pineal tumors. In addition, light and electron microscopic findings show that pineocytomas exhibit structural characteristics similar to those of the mature mammalian pinealocyte indicating a morphology clearly distinct from other tumors in this region.

11. LONG POST-OPERATIVE SURVIVAL WITH PRIMARY INTRACRANIAL SARCOMA

Philip H. Cogen, M.D., Mark C. Belza, M.D.,
Stephen Smith, M.D. (Stanford/Palo Alto CA)

Primary intracranial sarcoma is a rare neoplasm, most often found in the pediatric and adolescent age groups. Though sarcomas that arise systemically have been very well studied, both clinically and experimentally, little has been done with the primary CNS tumors. Approximately forty cases of primary intracranial sarcomas have been reported in the literature to date, though the complex pathologic classification associated with this lesion makes some of these patients questionable. Despite this, only two patients had long post-operative survival, the remainder following a rapid course of deterioration and death from tumor recurrence. The use of adjuvant radio- and/or chemotherapy appeared to have little altered their course. We describe here two cases of primary intracranial sarcomas in two adolescents with survivals of five and seven years to date, and examine the role of various etiologic and treatment factors in these patients.

The first patient presented at age 17 with seizure and headache, and a temporal mass on CT scan. Of note is the death of both her parents at a young age from systemic cancer. Following total excision of the lesion, the patient refused radiotherapy, and the mass re-grew to its pre-operative size and became symptomatic in 6 months. A second total excision was followed with radiation, and she is alive and well. The second patient also underwent two operative procedures, with subsequent radio- and chemotherapy. He too is alive and symptom-free at present. In each case, the pathology was consistent with sarcoma, without evidence of a systemic primary.

These cases are presented to discuss the neuropathology of this rare entity, as well as to discuss the role of adjuvant chemo- and radiotherapy. In addition, special stains and electron microscopy in these patients were most helpful. In particular, experimental sarcomas are known to be associated with oncogenic viruses and viral particles, though their role in the etiology of these tumors in humans remains controversial. Finally, we feel the long survival in these patients is important to discuss in order to guide the therapy of future individuals.

*12. MEDULLOBLASTOMA: A REVIEW OF THE FACTORS INFLUENCING PROGNOSIS. THE IMPORTANCE OF CELLULAR DIFFERENTIATION

Anthony J. Caputy, M.D., David C. McCullough, M.D.,
Herbert J. Manz, M.D., Kathleen Patterson, M.D.,
M. Kathryn Hammock, M.D. (Washington D.C.)

Clinical, therapeutic, and histologic features of fifty-four patients with medulloblastoma were analyzed with respect to prognosis. The overall five year survival was 60 percent, with 48 percent recurrence-free at five years. Cellular differentiation, when present, was associated with a significantly increased recurrence-free period. Seventy-two percent of those patients with the histologic finding of cellular differentiation were recurrence-free at five years. A marginally significant increase in five year survival was also seen with the presence of differentiation. Only 34 percent of the patients whose tumor exhibited necrosis were alive at five years.

There was no significant difference in five year survival for children under the age of three or for the group of children age five and under. However, the group of age five and under had a significant increase in the recurrence-free period. Seventy-two percent of this group were recurrence-free at five years. Other factors including sex, extent of surgical resection, Chang tumor stage, posterior fossa radiation dose, and adjuvant chemotherapy did not influence prognosis.

13. PRELIMINARY RESULTS OF DECREASED WHOLE BRAIN AND SPINAL CORD IRRADIATION IN CHILDREN WITH MEDULLOBLASTOMA

Michael S.B. Edwards, M.D., Victor A. Levin, M.D.,
William M. Wara, M.D. (San Francisco CA)

The use of standard radiation doses (4500-5500 whole brain and 4500 spine) delivered to the whole brain and spine for the treatment of children with medulloblastoma has been implicated in unacceptable delayed radiation toxicity. There has been an ongoing dialog between pediatric neurosurgeons and radiation oncologists as to the risk of decreasing the radiation dosage to prevent or decrease these late effects. The major concern is whether the pattern of recurrence will be affected such that there will be an increase in the recurrence pattern and frequency outside the posterior fossa.

In January of 1979 we initiated a Phase II protocol of decreased whole brain and spinal cord radiation for children with medulloblastoma. All patients, whether good or bad risk were entered into this study entitled PHRT (Procarbazine 100 mg/m²/day for two weeks prior to irradiation and Hydroxyurea 250 mg/m² q6h on MWF during irradiation. The radiation schedule was 5500 rad to the posterior fossa, and 2500 rad to the whole brain and spine). Thirty-seven children have been entered on this study. Twenty-seven (mean age 16 years) were classified as good risk based on post operative CT scans, myelograms and CSF cytology and 10 children (mean age 13 year) were placed in the bad risk group based on the same diagnostic tests.

The 27 children in the good risk group have a median time to treatment failure (Median TTF) of 173 weeks at the 60th percentile. The median cannot be calculated because so many patients are well without recurrence. The 13 children in the bad risk group have a median TTF of 75 weeks. Thirteen children have recurred to date. Only one patient recurred in the spinal cord, ALL others have recurred in the posterior fossa despite standard doses (5500 rad) of radiation. Toxicity of this protocol consisted of mild to moderate myelotoxicity from Hydroxyurea during irradiation.

We conclude that decreasing the dosage of radiation to the whole brain and spinal cord does not increase the failure rate in these locations. Whether 2500 rad will significantly improve neuropsychologic outcome in these children is presently under investigation.

*14. CT MYELOGRAPHIC EVALUATION OF SPINAL METASTASIS IN PNET OF THE CEREBELLUM

Richard E. George, M.D., John P. Laurent, M.D., Charles McCluggage, M.D., William R. Cheek, M.D. (Houston TX)

Primitive neuroectodermal tumors of the cerebellum account for 20% of brain tumors in children. These tumors are very radiosensitive and the mainstay of their therapy is radiation therapy. PNET have a tremendous propensity to metastasize via the cerebrospinal fluid pathways to seed the spinal canal and when first evaluated with metrizamide myelography, approximately 11 to 33% of these tumors already have documented spinal metastasis. The documentation of spinal metastasis is critical in these tumors as these metastatic deposits require larger doses of XRT for eradication. The current method of evaluating for spinal metastasis entails the usage of metrizamide myelography. Unfortunately, this method has difficulty evaluating the dorsal region of the thoracic spine adequately. CT myelography has recently been introduced as a means of enhancing the sensitivity of myelographic examinations of the spine. In a prospective study of 15 children with CT metrizamide myelography in the immediate post-operative period, an increased number of thoracic metastasis has been identified. Detection of metastasis changes prognostic factors in these children.

15. THE VALUE OF EARLY RE-OPERATION IN PEDIATRIC BRAIN TUMOR SURGERY

Harold L. Rekate, M.D., Andrew G. Shetter, M.D., Volker K. Sonntag, M.D. (Phoenix AZ)

The need for constant re-evaluation of management plans based on changing information is illustrated by two cases in which second operations were performed because of the response of the tumor to radiation in one case and radiation and chemotherapy in the other. In the first case a child with an ependymoma of the right lateral ventricle underwent radical subtotal removal of the tumor followed by radiation therapy. Post-irradiation CT scan revealed that the tumor may now be controlled surgically. In the second instance, a child with a malignant pineal teratoma underwent radiation therapy following surgical debulking. Conversion of Alpha fetoprotein levels to zero and continued growth of this large tumor led to a decision to attempt to remove the remainder of the tumor. In both of these cases, changes in therapeutic course were mandated by post-irradiation findings.

16. "8 in 1" CHEMOTHERAPY FOR MALIGNANT BRAIN TUMORS IN CHILDREN

Edward J. Kosnik, M.D., Arlynn Mulne, M.D., Frederick Ruymann, M.D. (Columbus OH)

Chemotherapy for malignant brain tumors in children has shown recent improvement in survival. One of the newer protocols was developed at Children's Orthopedic Hospital in Seattle and also piloted at Columbus Children's Hospital. This protocol is referred to as "8 in 1" therapy consisting of eight drugs given over a 12 hour period. This protocol was based on kinetic data showing a greater loss of malignant cells than normal cells when given in a shorter time interval. Individually active agents were included combining phase specific and nonspecific drugs and steroids for antiemetic and anti-edema effect. In the pilot study newly diagnosed patients received two courses of therapy at two week intervals followed by radiotherapy. Patients with recurrent tumors received courses of "8 in 1" therapy at 2-3 week intervals.

A total of 49 newly diagnosed and 23 recurrent patients were registered at Columbus Children's Hospital. Toxicity surveillance included blood counts, creatinine clearance, audiograms, liver function tests and electrolytes. With rare exceptions, toxicity including myelosuppression was tolerable. One patient with a large cystic lesion developed seizure activity followed by coma.

Survival data is presently being analyzed, however, there does appear to be a trend for improved survival in patients with newly diagnosed tumors.

17. METHOTREXATE LEUKOENCEPHALOPATHY MIMICKING CEREBRAL
ABSCESS ON CT BRAIN SCAN: A CASE REPORT

Paul Steinbok, M.D., Olof Flodmark, M.D.
(Vancouver, B.C., Canada)

A 7-year old girl with acute lymphocytic leukemia presented with a ten day history of progressive right hemiparesis. She had received previous prophylactic cranial irradiation and intrathecal methotrexate initially via the lumbar subarachnoid route and laterally via an indwelling Ommaya reservoir into the lateral ventricle. Nine months previously, she had been treated for Nocardia pyoarthrosis of one knee and lung abscesses. A CT brain scan showed a ring enhancing mass lesion in the left frontoparietal region with marked edema of the left cerebral hemisphere and a mid-line shift of 12 mm. A diagnosis of cerebral abscess or cerebritis was made. At craniotomy, intraoperative ultrasonography showed increased echogenicity in the suspected abnormal area but no abscess cavity. Needle aspirations showed softened brain which on microscopy revealed calcification and necrosis typical of methotrexate encephalopathy. Culture of the aspirate was negative. Follow-up CT brain scans showed gradual resolution of the mass effect, progressive calcification and diffuse contrast enhancement, which findings are more typical of methotrexate leukoencephalopathy. It is important to recognize that in those patients who are at risk, methotrexate encephalopathy must be considered in the differential diagnosis of ring enhancing cerebral mass lesions.

18. MALIGNANT GLIOMAS IN CHILDREN PREVIOUSLY TREATED FOR
ACUTE LYMPHOCYTIC LEUKEMIA

D. Luke Knox, M.D., Arnold H. Menezes, M.D., Robert L. Schelper, M.D., Renee Ellerbroek, M.D. (Iowa City IA)

The use of intrathecal methotrexate (ITMTX) and cranial irradiation for central nervous system prophylaxis in the treatment of acute lymphocytic leukemia (ALL) has been a major therapeutic advance. However, complications related both to acute and delayed neurotoxicity have hampered its success. The most worrisome of complications are now coming to light and include the development of gliomatous neoplasms following the treatment protocol. In this report we present two patients, both receiving ITMTX and cranial irradiation prophylactically, who developed an anaplastic astrocytoma and glioblastoma seven years after treatment. A review of the literature is also presented.

19. OPEN IMPLANTATION OF I-125 SEEDS FOR RECURRENT
MALIGNANT BRAIN TUMORS

Walker L. Robinson, M.D., Pradip P. Amin, M.D.,
Louis W. Solomon, M.D., Wilfred Sewchand, D.Sc.
(Baltimore MD)

Multimodality therapy, i.e., surgery, external beam radiotherapy and/or chemotherapy, has been shown to increase the quality of life and length of survival in many malignant lesions. Tumors, unfortunately, recur and are difficult to treat when maximal doses of radiation have already been given.

We have utilized open implantation of low intensity I-125 seeds to treat recurrent lesions after surgical debulking. The tumor configuration and volume is evaluated by radiation therapy preoperatively and dose plots prepared. Following surgery, the number and configuration of seeds is calculated based on the extent of the resection. The seeds are placed in a configuration which will give complete coverage of the remaining tumor volume and tumor bed. Seeds are implanted directly into residual tumor and tumor bed. Large cavities are treated by using Dacron felt as a matrix to hold the seeds in the desired configuration.

Four patients have been implanted, two with hypothalamic gliomas, one malignant meningioma and one mixed pinealoma. An average of 21 seeds have been implanted (range 9-30) with a total average dose of 15,000 rads (range 12,000 R - 15,000 R) being delivered in a year.

We feel that open implantation of low intensity I-125 seeds is another important weapon in the surgical arsenal. Further experience and evaluation is necessary before the complete utility of the procedure is known.

20. TREATMENT OF CYSTIC CRANIOPHARYNGIOMA WITH STEREOTACTIC INSTILLATION OF 32-PHOSPHOROUS

Stephen M. Papadopoulos, M.D., William H. Bierwalters, M.D., James A. Taren, M.D. (Ann Arbor MI)

A predominantly cystic craniopharyngioma in an acutely ill nine year old boy was treated primarily with stereotactic instillation of 32-Phosphorous with excellent clinical and radiologic results. Cyst volume decreased from 24 ml to 14 ml and 2 ml at one and two months respectively. Additionally, there was resolution of hydrocephalus and dramatic improvement in mental status and visual field deficits.

This technique has been previously used on several recurrent cystic tumors resistant to surgical therapy. This was based primarily on the excellent results in a large series of craniopharyngiomas treated by Backlund using 90-Yttrium, which is not available in the United States. 32-Phosphorous is a beta emitter that has a half-value layer in tissue of approximately 0.8 mm and an effective physical half-life of 14.3 days.

Using CT-stereotactic guidance the cyst was punctured through a small, frontal trephine. Three milliliters of fluid was aspirated. A dose of 32-Phosphorous to deliver approximately 20,000 rads to the cyst wall was then injected. A Bremstrahlung scan obtained at intervals postoperatively demonstrated no extravasation of the radioisotope.

This method offers the potential for immediate limited decompression of the cyst, treating the acute symptoms, and long term irradiation effects resulting in slow shrinkage of the cyst. Moreover, further surgical treatment is not precluded and hospital stay is shortened.

21. THE SYMPTOMATIC ARNOLD-CHIARI MALFORMATION: REVIEW OF EXPERIENCE AND SPECULATION

William O. Bell, M.D., Edward B. Charney, M.D., Derek A. Bruce, M.D., Leslie N. Sutton, M.D., Luis Schut, M.D. (Philadelphia PA)

During the ten-year period, 1975-1984, 22 patients with closed myelomeningoceles and shunted hydrocephalus presented with symptomatic Arnold-Chiari (A-C) malformations. Seventeen of the patients were aged six months or less. The remaining five patients varied in age from three to 23 years. The 17 patients aged 6 months or less presented with stridor, apnea, and/or feeding difficulty. The five older patients presented with either hemiparesis, quadriparesis, oscillopsia, nystagmus, or opisthotonos.

Fourteen of the 17 younger patients underwent surgical decompression of their A-C malformation. Of these 14, ten infants underwent decompression at 18 days or less following the onset of symptoms, and four underwent decompression at greater than 18 days. Following decompression at 18 days or less, five infants eventually expired secondary to continued symptoms from their A-C malformation, and five survived. Of those surviving, three patients were asymptomatic and two infants had continued symptoms, but were improved over their preoperative status. The results in the four late-operated group were also divided between those that survived and those that expired. Of the three infants who did not undergo decompression, two died and one eventually became asymptomatic. The five older patients who underwent decompression all had complete resolution of their preoperative symptoms and signs.

The authors conclude that decompression of a symptomatic A-C malformation does not always improve the clinical condition in the younger patient. This may be the result of ischemic/hypoxic effects on the infant brainstem which may not be normally organized at birth.

22. EVALUATION AND SURGICAL MANAGEMENT OF THE ARNOLD-CHIARI II MALFORMATION: USE OF MAGNETIC RESONANCE AND INTRAOPERATIVE ULTRASOUND

Keith L. Black, M.D., Joan L. Venes, M.D. (Ann Arbor MI)

Our experience with 17 consecutive patients with the Arnold-Chiari II deformity is reported. Magnetic Resonance (MR) imaging and intraoperative ultrasound was used in the preoperative evaluation and surgical management of these patients. We broadened our indications for surgery to include failure to thrive due to either early respiratory and swallowing dysfunction, progressive spasticity or upper extremity weakness. Surgery included not only bony decompression and dural grafting but drainage of the fourth ventricle and drainage of associated hydromyelia. All patients were noted on MR imaging to have extension of the vermian peg below C2. Three major types of fourth ventricular anomalies were identified: Type A-defined as no cystic dilatation of the fourth ventricle; Type B-defined as intracranial dilatation of the fourth ventricle; and Type C-defined as intraspinal dilatation of the fourth ventricle either dorsal to the cord or within the substance of the cord. Recognition of the variability of the Arnold-Chiari II malformation has enabled us to design operative approaches more specific to the structural abnormality. Ten of our seventeen patients significantly improved following surgery and four patients with a progressively deteriorating course were stabilized by surgery. Correlation with the age of the child at time of evaluation showed a clear tendency for the complexity of the lesion to increase with increasing age. In one case actual progression from a Type A to a Type B deformity was documented. This lends support to the argument for early intervention in this condition. Preoperative MR imaging and intraoperative ultrasonography has allowed us to tailor the operative approach to the specific pathologic anatomy.

*23. CENTRAL SLEEP APNEA IN ARNOLD-CHIARI TYPE I DEFORMITY

Anthony Jabra, M.D., Thomas Berger, M.D. (Cincinnati OH)

Arnold-Chiari Type I deformity consists of cerebellar tonsils herniation into the upper cervical canal without brainstem involvement. It is rarely accompanied by hydrocephalus, however, it is frequently associated with syringohydromyelia.

Central sleep apnea is the cessation of air flow lasting longer than 10 seconds with complete absence of diaphragmatic movements. This disorder may be secondary to medullary and upper cervical cord compression at the foramen magnum level with compromise of the involuntary respiratory center. Increased intracranial pressure due to uncontrolled hydrocephalus is usually an important contributing factor. Central sleep apnea has rarely been described in patients with Arnold-Chiari Type I deformity.

We report two patients, who, at 14 years of age, presented with progressive neurological deficit along with daytime hypersomnia and central sleep apnea, documented by polysomnography. The metrizamide enhanced computerized tomography revealed an Arnold-Chiari Type I deformity with diffuse intramedullary enlargement involving the entire cord. Following decompressive occipital craniectomy with cervical laminectomy and shunting of the syringohydromyelic cavity, myelography revealed notable reduction of the cord size and repeat polysomnography demonstrated fewer and shorter sleep apnea episodes. We believe that central sleep apnea becomes a feature of Arnold-Chiari Type I deformity when the syringohydromyelic cavity is extensive, compromising the respiratory center in the medulla and upper cervical cord. Rapid surgical decompression and shunting of the cavity may be rewarding.

24. AGGRESSIVE PHYSIOLOGICAL MONITORING OF THE PEDIATRIC PATIENT WITH ELEVATED INTRACRANIAL PRESSURE

Samuel S. Kasoff, M.D., Donovan Holder, M.D.,
Jack Stern, M.D., Ph.D., Nanakram Agarwal, M.D.,
Anthony SanFilippo, M.D., Thomas Lansen, M.D. (Valhalla NY)

ICP monitors were placed in all pediatric patients with Glasgow Coma Scale less than eight. Intensive physiological monitoring was performed on forty-two pediatric patients.

The patients ranged in age from three months to sixteen years. Two-thirds had head trauma and the remainder were patients with Reye's syndrome or other causes of elevated ICP (hypoxia, meningitis, SAH, tumor).

All patients were monitored utilizing epidural intracranial pressure monitors with continuous trend recording. Those patients who required either repeated doses of osmotic diuretics and/or Pentobarbital (to control intracranial pressure) also had Swan Ganz catheters placed by venous cutdown or the percutaneous route for physiological monitoring. The complication rates for placement of the intracranial pressure monitors and the Swan Ganz catheters were minimal. This combined method of intensive monitoring allowed the measurement of multiple physiological entities such as cardiac index, left ventricular stroke work, pulmonary artery wedge pressure, oxygen consumption, and perfusion pressure.

The aim of the various physiological manipulations was to maintain a perfusion pressure of the brain of forty millimeters of mercury, the intracranial pressure less than twenty millimeters of mercury, and to maintain a stable hemodynamic state. Abnormalities were rapidly diagnosed allowing therapeutic measures to be taken.

The alterations of left ventricular stroke work, preload, and the afterload were then treated with the administration of fluids and various pharmacological agents.

This study illustrates that Pentobarbital as well as intensive diuretics therapy, often results in the lowering of left ventricular function which would have decreased cerebral perfusion if untreated. This suggests that many failures of Pentobarbital therapy in the pediatric age group may be related to undiagnosed decreases in cardiac output resulting in decreased cerebral blood flow even with well controlled intracranial pressure.

25. PREVENTION OF INTRACRANIAL HYPERTENSION IN SEVERE PEDIATRIC HEAD INJURIES BY IMPROVING NEURAL AXIS COMPLIANCE

Arno Fried, M.D., Kenneth Shapiro, M.D. (Bronx NY)

Intracranial hypertension occurs in 80% of severely head injured children and adversely affects outcome. Earlier studies demonstrated that reduced compliance (Pressure Volume Index) accurately identified children in whom intracranial hypertension would occur. The present study was designed to 1) identify head injured children at risk of elevated ICP and 2) to prevent this complication by treating reduced compliance.

Severely head injured children (GCS<8) whose initial steady state ICP ≤ 15 mmHG were included in this study. PVI testing was performed and compared to the predicted normal PVI for each child derived from nomograms using external measurements. If the PVI was below 80% of predicted normal, treatment of reduced PVI was instituted and consisted of sedation, paralysis, hyperventilation and mannitol. Serial PVI's were performed during treatment. Treatment was continued until PVI reached 90% or more of predicted normal and then withdrawn. Continuous monitoring of ICP was performed during treatment and maintained for at least 48 hours after withdrawal.

The mean initial steady state ICP for the study group was 10.0 ± 4.3 (SD) mmHG. The predicted normal PVI for these children was 17.5 ± 4.8 (SD) ml. The initial measured PVI was 10.5 ± 2.0 (SEM) ml ($p < .001$) which was $58.6 \pm 9.7\%$ of predicted normal. After instituting therapy, the mean measured PVI improved to 14.4 ± 2.2 (SEM) ml or $82 \pm 7.5\%$ of normal. After completion of therapy the mean measured PVI was 15.8 ± 2.1 (SEM) ml or $90 \pm 3.5\%$ of normal. During the entire monitoring period the measured peak ICP was less than 20 mmHg of all children (mean ICP = 15.8 ± 3.1 (SD) mmHg).

This study indicates that pressure volume relationships can be improved by therapy directed toward reduction of intracranial volume. This enhancement of volume buffering capacity prevents intracranial hypertension from occurring in a group of head injured children in whom reduced PVI predicted marked elevation of ICP. Since elevated ICP after diffuse head injuries is a major cause of morbidity in children, the maintenance of normal ICP by prophylactically improving compliance may improve outcome.

26. THE CLINICAL MEASUREMENT OF BRAIN TISSUE PRESSURES-A
NEW DEVICE ADVANTAGEOUS FOR MEASURING INTRACRANIAL
PRESSURES IN THE PEDIATRIC AGE GROUP.

Richard C. Ostrup, M.D., Michael M. Todd, M.D.,
Mark H. Zornow, M.D., Lawrence F. Marshall, M.D.,
Thomas G. Luerksen, M.D. (San Diego CA)

Intracranial pressure (ICP) monitors currently in use for the pediatric population include ventricular catheters, subarachnoid screws and various epidural devices. Recognized problems with these different systems include difficulty with insertion, the risk of infection over long periods of time, and the potential of recording artifact or drift.

A new device which utilizes a 4 french fiberoptic catheter was developed. This monitor inserts through a 2 mm twist drill hole and can be directly placed into the brain parenchyma, thereby recording Brain Tissue Pressure (BTP).

We initially evaluated this device in an acute and chronic animal model. BTP recording from this monitor was compared to ICP recordings from a ventricular needle in regards to accuracy, drift, and responsivity over a wide range of pressures and recording times. There was excellent correlation in all facets studied between both monitors. Data regarding the accuracy, safety, and reliability of the fiberoptic device as well as comparisons between BTP and ICP will be presented. Preliminary data regarding the clinical use of the monitor and the advantages for use in the pediatric age group will be presented.

27. MEASURING REGIONAL CEREBRAL BLOOD FLOW AND
INTRACRANIAL PRESSURE IN PEDIATRIC SUBMERSION
ACCIDENTS WITH CARDIOPULMONARY ARREST

David H. Beyda, M.D. (Phoenix AZ)

To assess whether the measurement of regional cerebral blood flow (rCBF) using intracranial ¹³³Xenon was more effective than intracranial pressure monitoring for the treatment and prognosis of pediatric patients sustaining a submersion accident with a cardiopulmonary arrest, 14 children, 15 months to 11 years of age (mean: 22 months), were monitored using both methods.

Intracranial pressure monitoring was done using either a Richmond bolt or an intraventricular catheter. Measurement of rCBF-initial slope index (rCBF-ISI) was recorded. All patients had an initial rCBF measured within the first 12 hours of admission to the ICU and every 12 to 24 hours thereafter as long as the patient was comatose or outcome was evident. Of the 14 patients, 7 lived with complete recovery; 4 died; and 3 were vegetative. Patients (7) who lived with normal recovery had initial rCBF-ISI of 32.1 ± 2.3 cc/100g/min with recovery rCBF-ISI of 63.3 ± 5.2 cc/100g/min. Patients (4) who died had initial values of 28.7 ± 4.1 cc/100g/min. All patients were treated with hyperventilation (PaCO₂ 25-27), muscle relaxants and osmotic diuresis. In all patients intracranial pressure was always less than 15 torr.

Changes in regional cerebral blood flow following resuscitation seems to be predictive in determining outcome in this pediatric patient population. In addition, initial measurement of regional cerebral blood flow may also predict outcome. Patients with low flow states returning to normal validate the "reflow phenomenon" most commonly seen in patients after cardiac arrests. With the presentation of low flow states progressing to minimal flow states the evidence for brain death can be predicted early. The patients presenting with normal flow states initially are those that are most perplexing and suggest that relative early hyperemic states may not be beneficial. This study suggests that in this pediatric patient population intracranial pressure monitoring is not necessary and that measuring rCBF may be an accurate method to predict outcome.

28. NEUROPSYCHOLOGICAL OUTCOME AFTER SEVERE PEDIATRIC NEAR-DROWNING

Terece Stoval Bell, Ph.D., Leah Ellenberg, Ph.D.,
J. Gordon McComb, M.D. (Los Angeles CA)

Between April 1979 and August 1983, 49 severe near drowned children were admitted to Childrens Hospital of Los Angeles (CHLA) with Glasgow coma scores of 3,4 or 5 and underwent intracranial pressure monitoring and brain resuscitative therapy. Of the 49 patients, 29 (59%) died in the hospital 1 day to 3 months after admission. Thirteen (27%) were discharged in vegetative states, and 7 (14%) made good recoveries. No patient made a partial neurological recovery. The sustained mean highest intracranial pressure was significantly higher and the sustained lowest cerebral perfusion pressure was significantly lower for those who died than for survivors ($p < 0.05$), but this data did not significantly distinguish between intact and vegetative survivors. Pupillary reactivity noted on arrival at CHLA also discriminated survivors and fatalities ($p < 0.05$), but not between intact and vegetative survivors. The presence of any motor activity after arrival at CHLA, even posturing or twitching, indicated a significant chance for intact survival ($p < 0.05$), although such activity did not discriminate between death and vegetative survival. Extensive neuropsychological testing indicated that the apparently intact recovered patients generally showed nearly average levels of cognitive functioning, with mild residual gross motor and coordination deficits.

*29. SEVERE HEAD INJURY OUTCOME IN PEDIATRIC VERSUS ADULT PATIENTS

Anthony M. Alberico, M.D., John D. Ward, M.D.,
Sung C. Choi, Ph.D. (Richmond VA)

A consecutive series of 330 severely head injured patients were prospectively studied. All patients were treated with the same protocols by the same physicians and staff in the same intensive care unit. All patients had intracranial pressure monitoring. Of the 330 patients, 100 were in the pediatric group (0-19 years of age), and 230 were in the adult group (20-80 years of age). Statistical analyses were performed with regard to outcome, coma score, intracranial pressure course, and incidence of surgical lesions. The average emergency room as well as the 24 hour Glasgow coma score for each group was the same. The percentage of patients having normal, increased but reducible, and increased but not reducible intracranial pressure in each group was the same.

Overall, the pediatric patients had a significantly higher percentage of good outcomes (43%), than the adult patients (28%) ($p < 0.01$). They also had a significantly lower mortality (24%), than adults (45%) ($p < 0.01$). At one year following injury, pediatric patients had a 55% good outcome as compared to a 21% good outcome in adults ($p < 0.01$); this trend was evident at 3 months with the same p value. Pediatric patients with normal intracranial pressure had a higher percentage of good outcomes (70%), than adults (48%) ($p < 0.05$). There was no significant difference in outcome in pediatric and adult patients with increased intracranial pressure, regardless of whether or not it was reducible. There was a much higher incidence of surgical lesions in adult patients (46%), than in pediatric patients (24%) ($p < 0.001$).

30. PROGNOSTIC IMPLICATION OF GLASGOW COMA SCALE IN SEVERELY HEAD INJURED CHILDREN: THE PILOT TRAUMATIC COMA DATA BANK

T.S. Park, M.D., Wayne Alves, Ph.D., John A. Jane, M.D., Jan Hinkle, R.N. (Charlottesville VA)

In adults suffering from acute severe head injury, Glasgow Coma Scale (GCS) has permitted accurate prediction of their eventual outcome at an early stage of treatment. Whether the GCS has the same degree of prognostic value in the pediatric group remains uncertain. We have investigated correlation of mortality with the overall GCS, motor and eye responses of GCS and pupillary reflex in 105 children under the age of 18 who were prospectively entered into the Traumatic Coma Data Bank. All patients had a GCS of 8 or less at the time of admission, or deteriorated to 8 or less within 48 hours of head injury.

Overall mortality in patients under 18 was 34%. Patients with GCS 3 and 4 on admission had a mortality of 67% and 60% respectively. However, the mortality in a group with GCS 5 decreased markedly to 18% and the low mortality was maintained in patients with GCS 6-8 (18%, 14% and 18% respectively).

Motor response of the original GCS seen in all patients was reclassified into 3 groups: GCS 1-none, GCS 2,3,4-abnormal and GCS 5,6-purposeful. In keeping with the effect of overall GCS on the mortality, the mortality in patients with no motor response was 68% whereas it was lowered to 22% in patients with abnormal motor response and 27% in patients with purposeful movement. A greater proportion of survivors who had the abnormal motor response were disabled than those with purposeful movement.

Eye response was absent in a disproportionately large number of patients-86%. The absence of eye response was associated with death in 33%, moderate or severe disability in 21% and good recovery in 29%. In patients who opened the eyes spontaneously or in response to pain or sound, the mortality was 19%.

Relationship between the mortality and pupillary response was as follows: bilaterally absent response-67%, unilaterally absent response-42%, and bilaterally normal response-15%.

In presentation, the data from this study will be compared to those about adult patients.

*31. THE SHAKEN BABY SYNDROME

Ann-Christine Duhaime, M.D., Thomas A. Gennarelli, M.D., Lawrence E. Thibault, Sc.D., Derek A. Bruce, M.D. (Philadelphia PA)

Because a history of shaking is often lacking in the so-called shaken baby syndrome, diagnosis is usually based on a constellation of clinical and radiographic findings. We reviewed the charts of forty-eight cases of infants and young children with this diagnosis seen between 1978 and 1985 at the Children's Hospital of Philadelphia. We also constructed a series of whole-infant models by which the biomechanics of this injury could be studied.

All subjects had a presenting history felt to be suspicious for child abuse and either retinal hemorrhages or CT scan showing subdural or subarachnoid hemorrhage with interhemispheric blood. The physical exam and presence of associated trauma were analyzed; autopsy findings for the thirteen fatalities were reviewed. All thirteen fatal cases had signs of blunt impact to the head, though in more than half the cases these findings were noted only at autopsy. All deaths were due to uncontrollably increased intracranial pressure.

Models of one month old infants with various neck and skull parameters were instrumented with accelerometers and shaken and impacted against padded or unpadded surfaces. Angular accelerations for shakes were smaller than those for impacts by a factor of 50. All shakes fell below injury thresholds established for subhuman primates scaled for the same brain mass, while impacts spanned concussion, subdural hematoma, and diffuse axonal injury ranges.

We conclude that severe head injuries commonly diagnosed as shaken injuries require impact to occur and that shaking alone in an otherwise normal baby is unlikely to cause the shaken baby syndrome.

32. THE RARE ASSOCIATION OF A LEPTOMENINGEAL AND ARACHNOID CYSTS

David Knierim, M.D., Maged Abu-Assal, M.D. (Loma Linda CA)

A previously healthy 15 month old child suffered a minor head injury with no loss of consciousness. The child was evaluated because of irritability, nausea and vomiting. The neurologic examination was unremarkable. Head circumference was 2 standard deviations greater than the mean. Macewan's sign was positive. There was a nondisplaced right occipital skull fracture. CT and MRI scans revealed a very large posterior fossa multilocular cyst extending from the tentorial notch over both cerebellar hemispheres to the midline inferiorly. There was upward displacement of the tentorium and torcular Herophili, a normal cerebellum, and no ventricular enlargement.

Seventeen days post injury a small fluctuant mass was palpated over the fracture. Over a 3 day period the cyst grew rapidly causing distraction of the bony margins and a prominent subgaleal mass. At surgery, a leptomeningeal cyst was found to be communicating with a multilocular posterior fossa cyst. Microscopically, arachnoid membrane was identified.

We believe the presence of the arachnoid cyst contributed to the fragility of the skull and to the unusually rapid development of a true leptomeningeal cyst and growing skull fracture.

*33. PHARMACOKINETICS OF INTRAVENTRICULAR VANCOMYCIN IN HYDROCEPHALIC RATS

Matthew Howard, M.D., M. Sean Grady, M.D.,
T.S. Park, M.D., Michael Scheld, M.D. (Charlottesville VA)

Infection complicates 2-39% of CSF shunt insertions for hydrocephalus. Although the intraventricular route of antibiotic administration is commonly used in treating these infections, the pharmacokinetics, in vivo antimicrobial efficacy, potential neurotoxicity, and ideal CSF antibiotic concentrations of this route of administration are poorly understood. We developed a rat model that enables detailed study of intraventricular antibiotics administered in the setting of hydrocephalus, and used this model to study vancomycin. Adult rats received parietal craniectomies and intracisternal kaolin (0.1 ml; 300 mg/ml 0.9% NaCl). Three weeks later each rat received vancomycin 0.05 mg/ml CSF vol (≈ 0.045 mg/kg) in the right lateral ventricle. Bilateral ventricular samples were taken at 0.5, 1, 2, 4, 8 and 12 hour intervals after infusion and periventricular white matter was obtained for vancomycin concentration and histology.

1) The model is technically simple and reproducible (all animals were hydrocephalic); 2) rats are hardy (80% survival), readily available and inexpensive, enabling testing of large numbers; 3) CSF sampling and brain removal are accomplished rapidly allowing detailed CSF and tissue analysis at precise time intervals; 4) vancomycin is rapidly distributed ($T_{1/2} = 2.22h$) within the CSF and slowly eliminated ($T_{1/2B} = 19.65h$) with peak concentrations of 23.8 and 21.3 $\mu g/ml$ in the left and right ventricles respectively ($p = NS$). No detectable vancomycin was found in homogenates of the periventricular white matter ($\leq \mu g/g$) and histology showed no acute vancomycin-induced changes. Thus, the hydrocephalic rat is an effective, practical, in vivo model for the detailed study of intraventricularly administered antibiotics, useful for designing rational dosage schedules, testing for neurotoxicity, and potentially for therapy of experimental ventriculitis.

34. VANCOMYCIN PROPHYLAXIS FOR CSF SHUNT PROCEDURES

Johanna Goldfarb, M.D., Samuel S. Kasoff, M.D.,
Joseph Sciarrino, M.D. (Valhalla NY)

The Pediatric Neurosurgical Service at the Westchester County Medical Center performs approximately 125 shunt procedures annually. A significant proportion of these are in low birth weight newborns.

Following an increase in the rate of shunt infections in the early post-operative period with organisms resistant to nafcillin, pre-operative prophylaxis was changed from nafcillin to vancomycin (10 mg/kg I.V. slowly q6h x 24 hr.). The first dose was given on call to the O.R. Vancomycin levels in ventricular fluid at the time of surgery (approximately one hour after first I.V. dose) were low; mean level: 1.1 mcg/ml (± 1.3). Scalp cultures prior to surgery showed colonization with usual skin flora, mostly staphylococcal species (21/34). Infection rate was markedly decreased coincident with the change in prophylaxis regimen: one (1) infection in the first 50 procedures. The single post-operative infection occurred in a newborn with recurrent shunt blockages. The organism was a coagulase negative staphylococcus resistant to nafcillin, sensitive to vancomycin. There were no untoward side effects nor complications of the vancomycin therapy. These preliminary results suggest that therapeutic ventricular fluid antibiotic level at the time of surgery may not be necessary for adequate prophylaxis of early shunt infections. A study is presently being conducted in an attempt to determine the optimal time interval from administration of vancomycin to surgery.

35. REDUCED BACTERIAL ADHERENCE TO NEUROSURGICAL PROSTHESES

David J. Gower, M.D., Verlia C. Gower, M.S.,
Stephen H. Richardson, Ph.D., David L. Kelly, Jr., M.D.
(Winston-Salem NC)

Bacterial adherence to the surface of silicone plastic prosthetic devices is a frustrating and costly neurosurgical problem. Adherence is mediated by a negatively charged hydrophobic polysaccharide matrix known as the glycocalyx produced by the bacteria. This sticky matrix may also provide some degree of resistance to antimicrobial agents. The purpose of this investigation is to evaluate the effectiveness of modifications of silicone plastic in an attempt to reduce bacterial adherence.

A clinical isolate of Staphylococcus epidermidis was grown for one hour at 37°C in 100 ml of nutrient broth. Nutrient agar plates (100 mm) were overlaid with 5-ml aliquots of the broth and incubated overnight at 37°C in order to encourage maximum glycocalyx production. The bacteria were scraped from the surface and washed twice with phosphate-buffered saline (PBS), pH 7.4. The bacteria were then incubated with 2.5 mCi of sterile 51CR (a gamma emitter) with slow stirring. The radiolabeled bacteria were then circulated through control and experimental sections of silicone plastic tubing for two hours. The tubing was washed to remove all non-adherent bacteria and cut into sections approximately 2 cm in length. The number of bacteria were estimated using a gamma scintillation counter and the results normalized (CPM/cm²).

Preliminary data indicate that non-ionic detergents are the most effective means of reducing bacterial adherence to silicone plastic. In addition, pretreatment of the silicone tubing with bacitracin in aqueous solution inhibited bacterial adherence by 30%. These findings suggest that pretreatment of silicone prosthesis with bacitracin may potentially reduce the incidence of postoperative infection.

36. ROTATORY ATLANTOAXIAL LUXATIONS IN ADOLESCENTS

Arnold H. Menezes, M.D. (Iowa City IA)

Rotatory atlantoaxial luxation, though infrequently seen, occurs in the adolescent following trauma. It may go unrecognized if symptoms are minor or misdiagnosed when associated with brainstem or cervical myelography. An analysis of presentation, radiographic pathology and management of eight children presenting with this entity is made.

The series (10-16 years of age) comprised 6 males (5 football injuries, 1 wrestling) and 2 females (auto accident, fall on ice). Excruciating neck and posterior occipital pain brought 4 football injuries to immediate attention. Four other children were referred 2 days to 3 months later with progressive neurologic deficits as "brainstem vascular insults," "cerebellar tumor," and "cervical myelopathy." Neurodiagnostic procedures included plain cervical radiographs, tomography, CT, angiography and magnetic resonance imaging.

Rotatory luxation of the atlas was diagnosed when rotation exceeded 35° and if there was interlock on tomography/CT. Associated occipital dislocation and bizarre angulation of the skull (2), atlas bifida (1), Jefferson fracture, and compression of lateral Atlas mass were seen. Delayed vertebro-basilar artery occlusion (2).

Immediate reduction by traction was achieved in children presenting in the acute phase, maintained by external orthosis for 12 weeks, with resolution of the symptoms. Occipitocervical fusion was made in 2 children with chronic dislocation. Little improvement was seen in the patient who suffered vascular insults.

Rotatory luxation of the atlas is a distinct traumatic entity, more common in adolescents; requiring a high degree of suspicion for diagnosis and must be managed acutely.

37. PEDIATRIC SPINAL CORD AND VERTEBRAL COLUMN INJURIES

Joseph Zabramski, M.D., Mark Hadley, M.D., Carol Browner, R.N., Harold Rekate, M.D., Volker Sonntag, M.D. (Phoenix AZ)

We reviewed our experience with pediatric spinal trauma over the last 5 years. Fifty patients were identified (2 months to 16 years of age). There were 14 female patients (median age 9 years) and 36 males (median age 15 years). The injuries ranged from occipito-atlanto subluxation to lumbosacral fractures. Thirteen patients presented with multiple level fractures; 6 patients presented with subluxation without evidence of fracture, and 7 individuals had spinal cord injuries without evidence of fracture or dislocation. Initial neurologic status is presented in the table below.

INITIAL NEURO STATUS	TYPE OF INJURY			
	FX ONLY	FX/SUBLX*	SUBLX ONLY*NO	FX/SUBLX
INTACT (N=24)	7C/8TL/5L	4C	0	0
INCOMPLT(N=15)	1C/2TL/1L	3C	2C	3C/3T
COMPLT(N=11)	2T/2TL	2C	3C/1T	1T

*Key: C=Cerv, T=Thorac, TL=Thoracolumbar(T11-L2), L=Lumbar

Treatment included initial immobilization in all patients, followed by stabilization with a hard collar, halo vest or other brace in 23 patients, and surgery in 10 patients (7 cervical, 3 thoracolumbar).

Followup: No patients were made worse by therapy. The 24 patients who were admitted intact remained unchanged. Of the 15 patients with incomplete neurologic injuries on admission, 7 were intact on followup exam, 4 had made significant functional recovery, and 4 remained unchanged. Of those patients who presented with a complete myelopathy only 1 of 11 improved (bilateral locked facets C5-C6).

Seven patients presented with spinal cord injuries without evidence of fracture-dislocations. Only 2 of 7 were under 10 years of age (4 and 9 years). Four patients were 15 year olds and 1 was 16 years old. Five of 7 patients improved: 4 of 6 patients with incomplete cord lesions were intact at followup (3 of 4 thoracic, and 1 of 3 cervical level injuries). One patients with a complete myelopathy on initial evaluation did not improve.

We describe our approach to pediatric patients with vertebral column or spinal cord injuries, outline recommendations for treatment, and attempt to define the natural history of these lesions in this patient population.

38. THE CHALLENGE OF THE UPPER THORACIC SPINE

Stephen R. Marano, M.D., Stephen Bloomfield, M.D.,
Harold L. Rekate, M.D. (Phoenix AZ)

The lateral transthoracic approach to lesions of the anterior cervicothoracic junction is presented. Cadaver studies illustrate the regional anatomy and the ease with which visualization to the cervicothoracic spine can be obtained with this approach. Two cases are discussed in which the lateral transthoracic approach provided excellent exposure. An 18 month old patient with a severe congenital kyphoscoliosis and cervicothoracic spinal subluxation was treated by C-7 and T-1 corpectomies and anterior stabilization with a vascularized rib strut graft. The second patient, a 2 year old child with Pott's disease involving C-7, T-1, and T-2 underwent corpectomies of the involved vertebrae and anterior stabilization with a rib strut graft.

The lateral transthoracic approach is compared to the anterior transsternal and anterolateral supraclavicular approaches.

39. JUVENILE DISCS

A. Loren Amacher, M.D., Lloyd Zucker, M.D. (Hartford CT)

One hundred consecutive lumbar disc procedures carried out on the neurosurgical service of Hartford Hospital upon patients 18 years of age or less, are presented. Below age 18, sex ratio is even. An important clinical feature discovered was that free fragment occurrence is common among juveniles, in contradiction to previous clinical teaching. There is no consistent relationship between level of disc disease and age, activity, sex or body habitus. When disc rupture is associated historically with physical activity, interesting differences occur between girls and boys. Response to disc removal is gratifying, recurrence risk appears to be less than among adult patients.

40. LASER RESECTION OF 50 SPINAL LIPOMAS

David G. McLone, M.D., Ph.D., Thomas P. Naidich, M.D.
(Chicago IL)

We have had experience with over 100 lipomas of the spinal cord at Children's Memorial Hospital in Chicago. The CO₂ laser became available for resection of the last 50 consecutive lipomas. The lipomas are divided into 3 types: (1) Intramedullary lipoma; (2) Lipomyelomeningocele; and (3) Filari lipomas. Transitional forms of the 3 types are common. The majority of the patients were less than 1 year of age and asymptomatic at the time of surgery. All patients have either improved, 50% of symptomatic orthopedic problems and 7% of bladder problems, or have remained stable. No patient was made worse by surgery. Laser resection allows for almost bloodless surgery and near total removal of the intramedullary portion of the lipoma.

41. LIPOMYELOMENINGOCELE IN INFANTS AND CHILDREN

Rebecca Brightman, M.D., Edward J. Kosnik, M.D.,
Martin P. Sayers, M.D. (Columbus OH)

During the period 1964-1984 eighty two patients underwent surgical repair of lipomyelomeningocele at Columbus Children's Hospital. This represents 13% of the total number of all myelomeningocele patients (649) operated during that time.

We will present comparative data on patients operated at birth with those repaired later in life. Location and extent of defect will be discussed as well as associated anomalies, pre and postop deficit, need for additional surgical resection of lipomatous tissue and release of tethered cord.

The followup of these patients has been long-term and ranges from 1-20 years.

42. LUMBOSACRAL INTRADURAL INTRAMEDULLARY MYOLIPOMA;
UNUSUAL FEATURES OF A RARE TUMOR

David S. Knierim, M.D., Margaret Wacker, M.D.,
Maged Abu-Assal, M.D. (Loma Linda CA)

A one month old male presented with a fatty sacral mass with an associated strawberry-colored birth mark and a dimple. He was noted to have spina bifida from L3 to S3.

At surgery a dermal sinus tract was followed to deep fatty tissue in the dural planes. There was tumor associated with the cauda equina and a midline myelotomy above the conus medullaris revealed further intramedullary tumor. Stimulation of the conus medullaris caused the unusual phenomenon of contraction of the spinal cord itself as well as the expected conduction of impulses to the external anal sphincter as recorded on the EMG tracings. Stimulation of the tumor overlying the cauda equina caused only the contraction of the tumor and no conduction of impulses to the external anal sphincter. Stimulation of nerves roots within the cauda equina acted as a control as this caused conduction to the external anal sphincter without contraction of neural tissue.

Post operatively the patient had preservation of motor and sensory function in his lower extremities.

Histopathology revealed fibroadipose tissue with associated skeletal muscle in specimens taken from both the tumor overlying the cauda equina as well as that taken from within the spinal cord.

A review of the literature has shown that intradural intramedullary myolipomas are quite rare. Gowers described a similar case in 1962.

We would like to emphasize that intraoperative monitoring of neural function can be an aid to the preservation of neurological function.

43. ASSOCIATED SPINAL ANOMALIES OF CERVICAL MENINGOCELE
AND THEIR RADIOGRAPHIC EVALUATION

J.B. Delashaw, M.D., T.S. Park, M.D., Wayne Cail, M.D.,
Dennis G. Vollmer, M.D. (Charlottesville VA)

Spinal meningoceles are most commonly seen in the lumbar-sacral region and are infrequently observed in the cervical area. These lesions are primarily in the posterior midline and are not responsible for neurological deficits. Children with meningoceles have an excellent prognosis and typically have normal neurological development. However, the uncommon cervical meningocele may be associated with other spinal anomalies requiring close observation for neurological deterioration. The associated spinal anomalies will be illustrated by four children born with a cervical meningocele. Two children developed hydrocephalus as newborns requiring a ventricular shunting procedure. Klippel-Feil syndrome was observed in one child. Development of lower extremity neurological deficits occurred in three of these four children. Metrizamide spine computed tomography (CT) was performed on all four children. Lipomyelomeningocele with tethered cord and diastematomyelia was demonstrated in one child. Two children were found to have hydromyelia on delayed metrizamide spine CT. Recent magnetic resonance imaging (MRI) of the spine on two of these four children illustrated anomalies previously defined by metrizamide spine CT. The use of metrizamide spine CT and MRI scanning for evaluation of young children suspected of spinal anomalies will be discussed.

44. NMR OF THE TETHERED CORD

Nazih Mourfarrij, M.D., Joseph Hahn, M.D. (Cleveland OH)

Eight patients (mean age 11 years) with suspected cord tethering were evaluated preoperatively with nuclear magnetic resonance (NMR). The skin over the back was normal in 4 patients, one patient had a dimple, one patient had a fatty pad with a dimple and there was an old surgical scar after "closure of a fluid collection" at another hospital. All patients presented progressive urinary or lower extremity symptoms.

Myelography was not done in 4 patients. It was normal in one patient which the NMR showed a tethered cord. The myelogram showed an intraspinal meningocele in one patient and an intradural lesion which at surgery was an extension of an extradural lipoma in one patient. In the remaining 2 patients the myelogram correctly demonstrated cord tethering due to a thickened filum terminale.

The NMR correctly demonstrated the following abnormalities: the conus was anchored to a lipoma in 4 cases and to an area of moderately increased signal in the patient with previous surgery. This corresponded to scar tissue found at surgery. In the other 3 cases there was a low lying conus with a thick filum terminale. We conclude that with the availability of the NMR the need for a myelogram may be obviated in patients with suspected tethered cord.

45. TETHERED SPINAL CORD--EXTENSIBILITY OF LUMBAR AND SACRAL CORD

Satoshi Tani, M.D., Shokei Yamada, M.D. (Loma Linda CA)

The tethered cord syndrome is manifested by progressive motor and sensory deficits in the legs and incontinence. This disorder is associated with an elongated spinal cord and thick filum terminale or other factors that tether the spinal cord. Neurological deficits are attributed to the stretching of the lumbosacral cord.

The authors measured the extensibility of the lumbar and sacral cord segments in 16 cats. The laminectomy was performed under general anesthesia and the lumbar and sacral cord was exposed. A ligature was placed on the filum terminale and various weights were connected to the ligature to traction the cord. In general, the lower the segments, the more extensibility, and the upper segments were barely affected. Ninety percent or more of the elongation of each segment was noted within 3 seconds.

We correlate these results to the following clinical findings: 1) there is high incidence of incontinence in human cases of tethered cord; 2) repeated acute stretching enhances the clinical symptoms in addition to chronic tethering; 3) the elongation of each segment is proportionate to oxidative metabolic changes, more marked in sacral segment than in upper segment.

*46. METABOLIC AND HISTOLOGIC STUDIES IN A CHRONIC TETHERED CORD MODEL

Thomas Purtzer, M.D., Shokei Yamada, M.D.,
Satoshi Tani, M.D. (Loma Linda CA)

Pathophysiology of the Tethered Cord Syndrome (TCS) has been explained as impairment of the oxidative-metabolism in cord neurons using human patients with tethered cords. We have extended our studies to evaluate metabolic and histologic alterations in a chronic cat model so as to correlate the chronic stage model with previous studies.

Fifteen cats were studied. Lumbosacral laminectomy was performed under general anesthesia and the lumbosacral cord was tethered as previously described. Changes in the oxidation-reduction state of cytochrome a₃ (cyt a₃) during hypoxic stress (FIO₂ 0-5%) was analyzed using dual wave length reflectance spectrophotometry during acute and chronic tethering of the lumbosacral cord. Variable traction (1 gm, 3 gm or 5 gm) for different periods of time (1 wk., 1 mo., and 6 mo.) was applied. After chronic tethering, the oxidation-reduction status of the lumbosacral cord was studied before and after untethering. The lumbosacral cord was studied by light microscopy after appropriate fixation.

Our results indicate: 1) increasing traction leads to progressive impairment in oxidative metabolism which is acutely irreversible with severe (5 gm) traction; 2) chronic moderate traction (3 gm) induced a reversible metabolic deficit in all studied; 3) chronic severe traction (5 gm) induces a partially reversible metabolic deficit except at 6 months where a reversible deficit was found; and 4) there are no histological changes in neuron, glia myelin or vascular structures.

Study demonstrates: 1) a good correlation between human tethered cord and our chronic cat model; 2) progressive impairment in oxidative metabolism with increasing traction both acutely and chronically; 3) time dependent changes in oxidative metabolism of the chronically tethered cord which is improved with untethering; and 4) lack of histological changes indicating metabolic dysfunction as the cause of neurological impairment.

*47. HYPOPHOSPHATEMIA AND CRANIOSYNOSTOSIS

Hatem Megahed, M.D., John P. Laurent, M.D.,
William R. Cheek, M.D. (Houston TX)

Hypophosphatemia is a rare condition in which the basic biochemical defect has not been defined at this time. The hallmarks of the disease are increased calcium and decreased phosphorous in the serum with an increase in urine phosphoethanolamine and pyrophosphate. Alkaline phosphatase may be the malfunctioning enzyme.

Clinically, the manifestations are secondary to involvement of the bones of the body and calvarium. There is poor mineralization although osteoid formation continues at a normal or rapid rate. Osteoid apposition is what accounts for the craniosynostosis. With regard to other bones there is an increased tendency to fracture and involvement of the ribs leads to a restrictive pulmonary deficit.

There are two pitfalls in the radiological and clinical examination in children with hypophosphatemia. On x-ray, due to poor mineralization of osteoid, the fontanelles appear open. On clinical exam the fontanelle is bulging, yet the head growth remains insignificant. At surgery the explanation is simple. The osteoid has proliferated and meets at the sutures creating a restrictive effect on head growth.

At surgery there are increased risk of complications. During the operation care should be taken to avoid removing osteoid over the saggital sinus since this is adherent. Bleeding is not tolerated well because of poor cardiovascular function and restrictive pulmonary problems. There is also an increased chance of fracture in positioning during surgery. Postoperative hypercalcemia may occur.

48. PEDIATRIC NEUROSURGICAL IMPLICATIONS OF THE AMNIOTIC BAND DISRUPTION COMPLEX

Roger J. Hudgins, M.D., Michael S.B. Edwards, M.D.,
Douglas K. Ousterhout, M.D., Mahin Golabi, M.D.
(San Francisco CA)

The amniotic band disruption complex (ABDC) may vary from simple digital constriction bands to major scalp, craniofacial, and visceral defects and may be a major cause of stillbirth (7%-14%). The etiology is purported to be related to amnion disruption frequently secondary to maternal-fetal trauma with resultant constriction/compression of the developing fetus. However, many associated anomalies such as holoprosencephaly, hydrocephalus, and isolated neural tube defects cannot be fully explained by this mechanism, but may be a result of amniotic disruption. The use of prenatal ultrasound has allowed the diagnosis of the ABDC feasible early in utero raising the possibility of intervention during gestation. We have evaluated 50 infants with the ABDC since 1980. The majority have been seen during the last three years, suggesting an increased awareness of this problem. Eight neonates have required pediatric neurosurgical intervention for varied lesions. Acute management problems consisted of shunting for hydrocephalus in 3 children and closure of scalp defects in 5 children. All eight children required some form of craniofacial reconstruction within the first six months of life. Despite the initial severity of the defects, an initial decision not to treat 2 infants did not result in neonatal death necessitating delayed repair. The ABDC is a more common cause of scalp, craniofacial and neurologic structural anomalies than previously recognized. A combined craniofacial team approach to the management of these children can maximize cosmetic and neurologic outcome. Our theories regarding the etiology of the ABDC, its diagnosis, management, and outcome will be presented.

49. AUDITORY & SOMATOSENSORY EVOKED POTENTIALS IN THE LOCALIZATION OF BRAINSTEM GLIOMAS

John W. Walsh, M.D., Robin Gilmore, M.D.,
Augusto C. Lastimosa, M.D., Robert J. Baumann, M.D.,
Norman Bass, M.D. (Lexington KY/Arlington TX/Augusta GA)

Brainstem gliomas (BSGs) are generally regarded as tumors with a very poor prognosis. Recently, however, investigators have described small groups of patients with this tumor who have longer survival times. This finding has provided the impetus to reconsider biopsy as a guide to diagnosis and treatment. However, the frequency of successfully obtaining tissue from the tumor biopsy has been disappointing. Primarily this has been due to poor localization. Non-invasive methods of localization are needed. The combined use of Brainstem Auditory Evoked Potentials (BAEPs) and Somatosensory Evoked Potentials (SSEPs) permits discrete brainstem localization of tumor and assessment of tumor asymmetry. This is especially important as one chooses the appropriate biopsy site most likely to yield the diagnosis.

Eight patients with BSGs who had BAEPs, SSEPs and CT Scans were examined. BAEPs were found to be very sensitive indicators of the presence of tumor and of tumor asymmetry; while SSEPs were not as sensitive as BAEPs, they did provide electrophysiologic confirmation of tumor asymmetry which was extremely useful on those occasions when BAEPs were symmetrically abnormal and/or the CT Scan demonstrated a midline lesion. Combined BAEPs and SSEPs were also useful in assessment of therapeutic response and in the determination of prognosis.

50. PATHOLOGICAL FACTORS WHICH EFFECT THE EVOKED RESPONSE

Derek Bruce, M.D., Luis Schut, M.D., Leslie Sutton, M.D.,
Byung-kyu Cho, M.D. (Philadelphia PA)

Evoked responses are becoming an increasingly common tool for intraoperative monitoring in neurosurgical procedures. Nonetheless, there is little evidence to support the thesis that these monitoring techniques will improve the safety of surgery. This paper reports a series of experimental studies in cats in which the evoked response, somatosensory and brainstem were examined during the induction of elevated intracranial pressure and cerebral edema.

50. PATHOLOGICAL FACTORS (cont.)

Cats were anesthetized with ketamine intraperoneally, paralyzed and ventilated on a Horowitz small animal ventilator. Screw electrodes were placed over the somatosensory cortex bilaterally with reference electrode in the frontal sinus and in the ear. Somatosensory and brainstem evoked responses were performed prior to producing the insult. In six cats, intracranial pressure was elevated by producing decompensation in animals with compensated kaoline-induced hydrocephalus. Perfusion pressures as low as 10mmHg were obtained. In the edema animals, brain edema was induced by two methods. A liquid nitrogen cold lesion to the cortex of the brain was the initial method and, secondly, infusion of mock CSF into the deep white matter of the frontal lobe involving the thalamocortical projection. Each cat in these experiments was used as its own control, one hemisphere receiving only mock CSF, the other mock CSF at different pH and with different chemicals. Six cats were infused with lactate of a concentration of 30mmoles per liter and 18 cats were infused with glutamate buffered to a normal pH of 7.4, 5.7 and 3.8. Finally a group of animals were made borderline ischemic by the induction of systemic hypotension and carotid occlusion to produce burst-suppressed EEG.

The somatosensory and brainstem evoked responses were found to be extremely resistant to elevated ICP and only began to change at a point where severe total brain ischemia was expected. The evoked responses were not sensitive to greater changes in ICP. In the animals with edema, edema itself appeared to have no effect on the evoked responses. Acidosis within the tissue appeared to have no response on the evoked responses nor did high concentrations of lactate. It was interesting that in the glutamate animals in combination with a lower pH, changes in the latency of the central conduction time of the somatosensory evoked responses were identified. In the animals with ischemia, white matter ischemia appeared to be a significant factor in prolonging the somatosensory evoked response.

We conclude that current evidence suggests that somatosensory and brainstem evoked responses are minimally sensitive to many of the insults that occur during surgical procedures and caution against pressing too much reliance on the lack of change or the presence of changes of these electrical measurements during neurosurgical procedures.

51. OUTPATIENT METRIZAMIDE STUDIES IN CHILDREN

Alexa I. Canady, M.D. (Detroit MI)

More than fifty metrizamide CT and/or myelograms have been performed in children less than fifteen years of age in the last two years at Children's Hospital of Michigan. More than half of these studies have been done as outpatients. Problems studied include Arnold-Chiari malformation, tethered cord, syringomyelia, spinal cord tumor, lipomenigocele and CSF fistula.

Outpatient studies have proven to be a safe and cost efficient alternative. The procedure for the outpatient studies and all the complications will be discussed.

52. THE ANTERIOR COMMISSURE AS A MAJOR LANDMARK IN MRI

Thomas P. Naidich, M.D. (Chicago IL)

Correlation of microcryotomic and myelin-stained sections of human cadaver heads with spin-echo magnetic resonance images (MRI) documents that MRI routinely displays the anterior commissure in 3 orthogonal planes as a distinct white matter tract that resembles "bicycle handlebars". The anterior commissure crosses the midline at the upper end of the lamina terminalis, just anterior to the anterior columns of the fornices. To each side of midline, it courses antero-inferolaterally in relationship to the nucleus accumbens septae, the head of caudate nucleus and the anterior limb of internal capsule. It forms a genu within the inferior portion of the lateral nucleus of globus pallidus and then courses postero-inferolaterally under putamen to run with the white matter of the external and extreme capsules toward the middle and inferior temporal gyri. Because the anterior commissure is easily recognizable in all 3 planes at differing pulse sequences, the commissure has proved to be a major landmark for identifying the complex anatomy of this region, especially in sagittal sections. Demonstration of the commissure assists in localizing mass lesions more precisely and in characterizing congenital anomalies.

53. BENIGN EXTRA-AXIAL COLLECTIONS OF INFANCY

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The significance of extra-axial fluid collections in infants presenting with macrocrania continues to be debated. The literature includes observations on several series of such infants with confusing conclusions regarding etiology, locations of the fluid, possible need for treatment, and prognosis. In an effort to determine the clinical and developmental prognosis we have reviewed our experience with 57 infants of less than 1 year of age in whom excessive extra-axial fluid was noted on CT scan. Of this group, 15 infants had macrocrania and therefore could not be interpreted as having cerebral atrophy. The purpose of the study was to determine the outlook in this selected group and possibly to define pathophysiologic factors.

Fifteen infants were referred for evaluation of macrocrania. There were 12 males and 3 females in this group. All infants were full term gestations except two infants who were delivered at 36 weeks gestation. The mean age at presentation was 3.9 months. All infants had occipital-frontal head circumference (OFC) measurements at or greater than the 90th percentile for postnatal age. All infants except two had attained normal neurodevelopmental milestones for age. Physical exams were otherwise normal. No infant had a history of antecedent head injury (birth trauma) or intracranial infection.

Diagnostic evaluation included B mode head ultrasound and head computerized axial tomography in all infants. These studies revealed enlargement of the extra-axial fluid space in all infants. Four infants underwent radionuclide lumbar cisternography revealing delayed appearance of isotope over the cerebral convexities. No treatment was undertaken.

Eleven of these 15 infants were seen in followup at ages ranging from 5 months to 2 1/2 years of age. In most cases OFC's remained at or greater than the 90th percentile. One infant continued to exhibit mild delay in neurodevelopmental parameters. The remaining infants, however, demonstrated normal development.

53. BENIGN EXTRA-AXIAL (cont.)

We conclude that there is a population of healthy, term-gestation infants presenting with macrocrania in early infancy that are either developmentally normal or exhibit mild degrees of developmental delay. They have characteristic head ultrasound and head computerized tomography findings. In followup, these infants continue to exhibit normal neurodevelopment or show improved development if previous delays were apparent. It is for this group of infants that we prefer the term "benign extra-axial collections of infancy". There is no indication for treatment. The etiology and pathophysiology have not been determined.

54. RATE OF DECREASE IN VENTRICULAR SIZE AFTER VENTRICULOPERITONEAL SHUNT PLACEMENT

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Serial computerized ultrasonic evaluations (Octoson, Picker Co.) were done in 16 children with hydrocephalus before and after placement of a ventriculoperitoneal shunt. Six had myelomeningocele and hydrocephalus, eight developed hydrocephalus after a germinal matrix hemorrhage, and two following meningitis. Age ranged from 1 day to 11 months. The diameter of the left atrium was chosen as the measured variable, because it was reliably visualized on all scans and was unlikely to contain air on the early scans. During the first six days of shunting an average of 74% of the total amount of decrease occurred. The total amount of decrease was arbitrarily measured at six months.

Postoperative complications such as mantle collapse and subdural hygroma were readily apparent as were the development of intraventricular bands and cysts. Ventricular size frequently increased days to weeks before clinical shunt failure and became a useful predictor that allowed elective shunt revision.

55. COMPUTERIZED SINGLE PROBE SYSTEM: ASSESSMENT OF CSF FLOW RATES THROUGH THE SHUNTING DEVICES

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One of the complications involved in valve regulated hydrocephalic patients comes from their inadequate flow rates either poorly drained, or rather over drained resulting in so-called slit-like ventricles eventually. In avoidance of these undesirable sequelae in shunt dependent patients, it becomes often crucial to measure actual flow rates. Most of the methods previously developed are quite satisfactory, in that sense, in measuring CSF flow rates through the readily implanted systems, however, the measurements are only feasible when the patients are in their horizontal position in most of the cases, and real flow rates are hardly available when the patients are in their semi-sitting or upright positions.

Using CdTe (Cadmium telluride) as a detector, the authors have developed a computerized single probe system designed for CSF shunt flow assessment. The CdTe detector is so small in size that the device can be snugly attached to the scalp over the reservoir after some 100 to 200 microcurie of Tc-99m pertechnetate, less than 0.01 ml in volume, is introduced into the reservoir. The data obtained is stored in a microcomputer. The total study time can be arranged from 3 sec. and as long as several hours depending on the purpose of the study. Flow rate was computed by the following formula: $F = \lambda V$, where V is the volume of the reservoir and λ is a decay constant. Advantageous points with this method are: the measurement can be made at any position of the patient and the flow rate could be continuously assessed, if required. Some clinical data will be presented and discussed.

56. CSF DRAINAGE IN THE DEAD RABBIT

J. Gordon McComb, M.D., Shigeyo Hyman, M.S.,
Martin H. Weiss, M.D. (Los Angeles CA)

Although mounting anatomic and physiologic evidence supports CSF drainage via open channels this point is not without question. The open channel model would be solely pressure responsive and allow for passive escape of macromolecules whereas a closed pathway would add the factors of osmosis and filtration and macromolecules would require an active transport process to cross an intact endothelium. If CSF drainage is strictly a pressure dependent passive process via open channels, death of the animal should not noticeably effect CSF egress.

Two groups of New Zealand white rabbits were anesthetized with pentobarbital and underwent a four hour ventricular infusion with artificial CSF containing indigo carmine and I-125 radio-iodinated serum albumin (RISA). In one group the rabbit's physiologic condition was kept normal for the four hour infusion while the other group was killed with an overdose of pentobarbital at the onset after assuring proper placement of the bilateral ventricular cannulae.

The distribution of indigo carmine and RISA was similar within and outside the central nervous system in both groups of rabbits.

The above findings indicate that macromolecules in CSF drain primarily by a pressure dependent open channel passive process.

57. THIRD VENTRICLE BB AND HYDROCEPHALUS: OPERATIVE CURE

Eldon L. Foltz, M.D. (Orange CA)

A 12 year old boy suffered a gunshot wound of the right eye from a BB gun, and the pellet penetrated and destroyed the right eye, perforated the orbital roof and traversed the brain to stop in the mid portion of the left hemisphere. Recovery from brief unconsciousness was prompt, and the only permanent neurological deficit was complete loss of right eye function. Four months later, the pellet had migrated from the mid left hemisphere to midline 3rd ventricle. By x-ray, the pellet appeared to be at the orifice of the aqueduct of sylvius. The pellet was a copper-clad carbon steel BB.

Three years later, progressing hydrocephalus from partial aqueduct occlusion was clear. The patient suffered from headache, severe lethargy and hypersomnolence.

Thorough clinical evaluation included accurate CSF pressure measurements, serial CT scans, isotope CSF bulk flow studies, and pneumoencephalogram/pneumoventriculogram. Only minimal scarring around the BB was apparent, and therefore operative removal was accomplished by craniotomy, using a parasagittal transcallosal entry into the anterior 3rd ventricle. The BB was removed by means of a small, powerful Alksne magnet with localizing aid by C-arm image intensification. No recognized neurological deficits resulted.

The hydrocephalus was reversed and at six months postoperative the patient is again active and leading a near normal life. He never did have a CSF shunt placed.

By photographic presentation, emphasis will be placed on: 1) the nature of copper-clad pellets in the brain which allows them to migrate; 2) the cause of the clinical symptoms in this instance related to not only progressing hydrocephalus but local destruction of peri-aqueductal gray matter by the copper-clad BB; 3) the operative technique to emphasize this transcallosal approach as a major option for all lesions of the 3rd ventricle, and probably including aqueduct as well.

58. RANDOMIZED INDOMETHACIN TRIAL FOR THE PREVENTION OF INTRAVENTRICULAR HEMORRHAGE IN VERY LOW BIRTH WEIGHT NEONATES

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Many observers believe that local cerebral blood flow is controlled in part by prostaglandins. Prostaglandins are synthesized de novo from arachidonic acid by the cerebral microvasculature; in the cyclo-oxygenase, or first portion of the pathway, arachidonic acid is converted to endoperoxide compounds. Potentially tissue-injurious free radical species, such as the superoxide anion, are produced at this stage. The endoperoxide compounds are converted to the various prostaglandins found in all organ systems by the prostaglandin-specific synthetases. Indomethacin blocks the cyclo-oxygenase pathways of prostaglandin synthesis and prevents the morphologic and permeability changes found in the microvasculature in response to ischemic and acute hypertensive insults, possibly by decreasing free radical production. In newborn beagle pups exposed to a hemorrhagic hypotension/volume re-expansion model for GMH/IVH, indomethacin prevents this insult. Prospective data have demonstrated that indomethacin closes the patent ductus arteriosus (PDA), and recent data suggest that this agent may prevent GMH/IVH in this same patient population. We report a randomized prospective trial of indomethacin to prevent GMH/IVH in very low birth weight neonates. We admitted 48 preterm neonates of 600-1250 g birth weight and negative 6 hour echoencephalography (ECHO) studies to a randomized prospective indomethacin/placebo trial for the prevention of neonatal intraventricular hemorrhage (IVH). Beginning at 6 postnatal hours, indomethacin or placebo was administered intravenously q 12 hours for a total of five doses. Six indomethacin treated infants experienced IVH compared to 14 control infants ($p = 0.02$). The indomethacin treated group had significant decreases in their serum prostaglandin values 30 hours after the initiation of therapy. The overall incidence of patent ductus arteriosus (PDA) was 82% at 6 postnatal hours; 84% of the indomethacin treated infants experienced closure of the PDA compared to 60% of the placebo treated patients. Closure of the PDA was not related to the incidence of IVH. We speculate that indomethacin may provide some protection against neonatal IVH by acting on the cerebral microvasculature.

59. INTRACRANIAL HEMORRHAGE IN THE POST-TERM INFANT

Michael D. Heafner, M.D. (San Antonio TX)

A retrospective review of our experience with intracranial hemorrhages in post-term infants revealed two cases of intraventricular hemorrhage, one subdural hematoma, and one case of a thrombosed anomalous venous sinus. The case histories, radiographic and operative findings, and a discussion of the relevant literature will be presented. Intracranial hemorrhage in the post-term infant is an uncommon occurrence with diverse etiologies. In contradistinction to the premature infant, the higher probability of finding something other than a germinal matrix hemorrhage in the post-term infant demands a more rigorous search for a surgically amenable vascular lesions. We suggest that digital angiography may be particularly useful in this regard.

60. DIAGNOSIS AND MANAGEMENT OF INTRACRANIAL ANEURYSMS AND PSEUDOANEURYSMS PRESENTING DURING INFANCY AND CHILDHOOD

Francisco Gutierrez, M.D., Herbert Engelhard, M.D.
(Chicago, IL)

Intracranial aneurysms are rarely found in the pediatric age group. When they do occur, clinical presentation is variable and management is often difficult. We reviewed all cases of intracranial aneurysms and pseudoaneurysms presenting to Children's Memorial Hospital over the past twelve years. Vein of Galen "aneurysms" were not included in the study. Ten patients were identified ranging from 2 months to 10 years of age. Eight patients were male and 2 female. Two patients were found to have fusiform dilatations of portions of the vertebrobasilar system. One patient had a single berry aneurysm and another patients had multiple berry aneurysms. In 3 patients, the aneurysm was associated with an AVM or tumor. Of the remaining three patients, 1 had a false aneurysm, 1 had a mycotic aneurysm of the intracavernous portion of the internal carotid artery and 1 had bilateral post-traumatic internal carotid artery aneurysms. A typical picture of subarachnoid hemorrhage was present in only 2 patients. Three patients presented with intracranial hematomas. Three patients presented with seizures. One patient developed a third nerve palsy. One aneurysm was discovered incidentally at the time of surgery for an astrocytoma. One patient's aneurysm was found during evaluation for lethargy occurring after head trauma.

60. DIAGNOSIS AND MANAGEMENT (cont)

Five patients required surgical intervention for the aneurysm: 4 underwent craniotomy and 1 had a carotid ligation. Three patients developed hydrocephalus and required ventriculoperitoneal shunt placement. Patients were also treated with anticonvulsants and sedation, as required. Two patients expired. Most had residual neurological deficit, which improved. The diagnosis of intracranial aneurysm should be kept in mind when dealing with children and infants presenting with severe or atypical neurological findings. Management must be tailored to the individual patient.

61. EXPERIENCE WITH A MODIFIED JANE PROCEDURE FOR SCAPHOCEPHALY

W. Jerry Oakes, M.D., Joseph Piatt, M.D. (Durham NC)

With the advent of continuous intraoperative monitoring, specialists devoted to pediatric anesthesia, and relatively safe blood transfusion, infants with craniosynostosis have undergone a variety of operative procedures to correct abnormal head shapes. The initial approaches to reverse scaphocephaly (simple craniectomy) relied upon the developing brain to remold the skull. Since significant brain expansion is necessary to reshape the skull these procedures were best done within the first few months of life and had little effect on the skull shape after 9 to 12 months of age.

An alternative approach that did not heavily rely on further expansion of the brain with secondary skull remodeling would seem better suited for the older infant. This led us to initially attempt immediate remodeling of the skull at the operating table in infants more than 12 months of age with scaphocephaly. The results in that limited group were so rewarding that a modification of the medial bony advancement described by Jane has now been adopted as the standard procedure for the correction of scaphocephaly at all ages. With significant experience in the past with both median and bilateral paramedian linear craniectomy as well as more than 15 infants having undergone a modified Jane procedure the more aggressive approach appears justified. Not only has the procedure proven relatively safe but the cosmetic results make these patients virtually indistinguishable from children with normal skull shapes. The technique and details of the intraoperative support given to these patients will be reviewed.

62. NEUROSURGERY IN A NEONATAL INTENSIVE CARE UNIT

Thomas S. Berger, M.D. (Cincinnati OH)

Eighteen operations were performed in a neonatal intensive care unit in a large teaching general hospital during a twenty month period. The operative procedures included placement of intracranial reservoirs, repair of myelomeningoceles and ventriculoperitoneal shunts. There were no complications (including no infections).

The techniques used and the advantages of performing surgery in this location will be presented.

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